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Heating · Piping and Air Conditioning

December, 1930

Articles on

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Piping—
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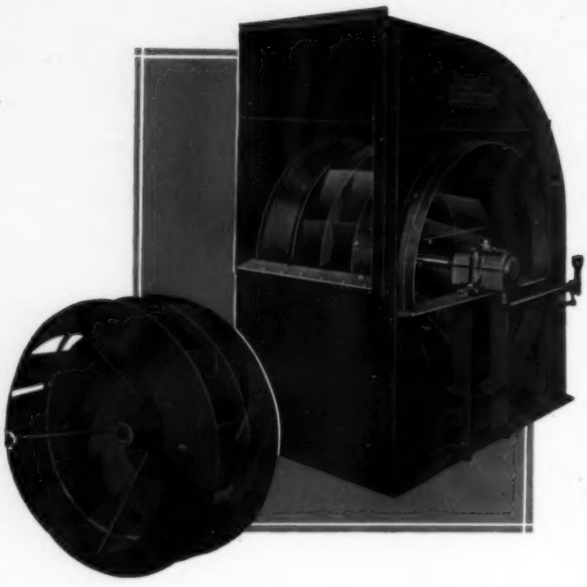

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TABLE OF CONTENTS

DECEMBER, 1930

Page

HIGHER PRESSURES AND TEMPERATURES AS THEY AFFECT THE DESIGN, INSTALLATION AND MAINTENANCE OF PIPING 985
By J. J. Harman

CONTROL OF SOUND IN BUILDINGS 992
By F. R. Watson

FUEL CONSUMPTION IN TOLEDO SCHOOLS 997
By Samuel R. Lewis

FIGURING PRESSURE AND TEMPERATURE DROP IN A HOT WATER PIPING SYSTEM 1001
By P. M. Greenwell

NEW ALIGNMENT CHART FOR COMPUTING THE PRESSURE DROP DUE TO THE FRICTIONAL RESISTANCE OF A FLOWING FLUID 1003
By Temple C. Patton

FIVE SYSTEMS VENTILATE APARTMENT-MUSEUM 1007
By Maria Sermolino

DECREASED DEATH RATE OF POULTRY REPRESENTS LARGE PROFIT—PROPER AIR CONDITIONS AN AID 1008
By John H. Ruckman

SWEEPING COBWEBS OUT OF THE SKY 1012
By Malcolm Tomlinson

INSIDE AIR CONDITIONS BALANCED WITH OUTDOOR TEMPERATURE 1015
By Will H. Mayes

COOLERS MAINTAIN UNIFORM TEMPERATURES 1017

INTERVIEWS OF INTEREST 1019

PERFORMANCE DATA FOR FORTY-SEVEN UNIVERSITY BUILDINGS ON NORTH CAROLINA CAMPUS 1021
By I. W. Summerlin

MANUFACTURE AND PROPER USE OF WOOD REQUIRE AIR CONDITIONING 1026
By W. LeRoy Neubrech

A BRIEF REVIEW OF PIPE STANDARDIZATION 1030

"OPEN FOR DISCUSSION" 1031

EDITORIALS 1071

PRACTICAL PIPING PROBLEMS 1073
By W. H. Wilson

INDEX FOR VOLUME II (ADVERTISING SECTION) 165

ADVERTISERS' INDEX (ADVERTISING SECTION) 176

JOURNAL SECTION OF A. S. H. V. E.

Air Conditioning for Railway Passenger Cars, by A. H. Candee 1037

Air Leakage Through Various Forms of Building Construction, by F. C. Houghten, Carl Gutberlet, and C. A. Herbert 1044

Noise and Ventilation, by G. T. Stanton 1049

An Automatic System of Hot Water Heating and Hot Water Supply, by Erwin L. Weber 1053

Bulletin Section 1057

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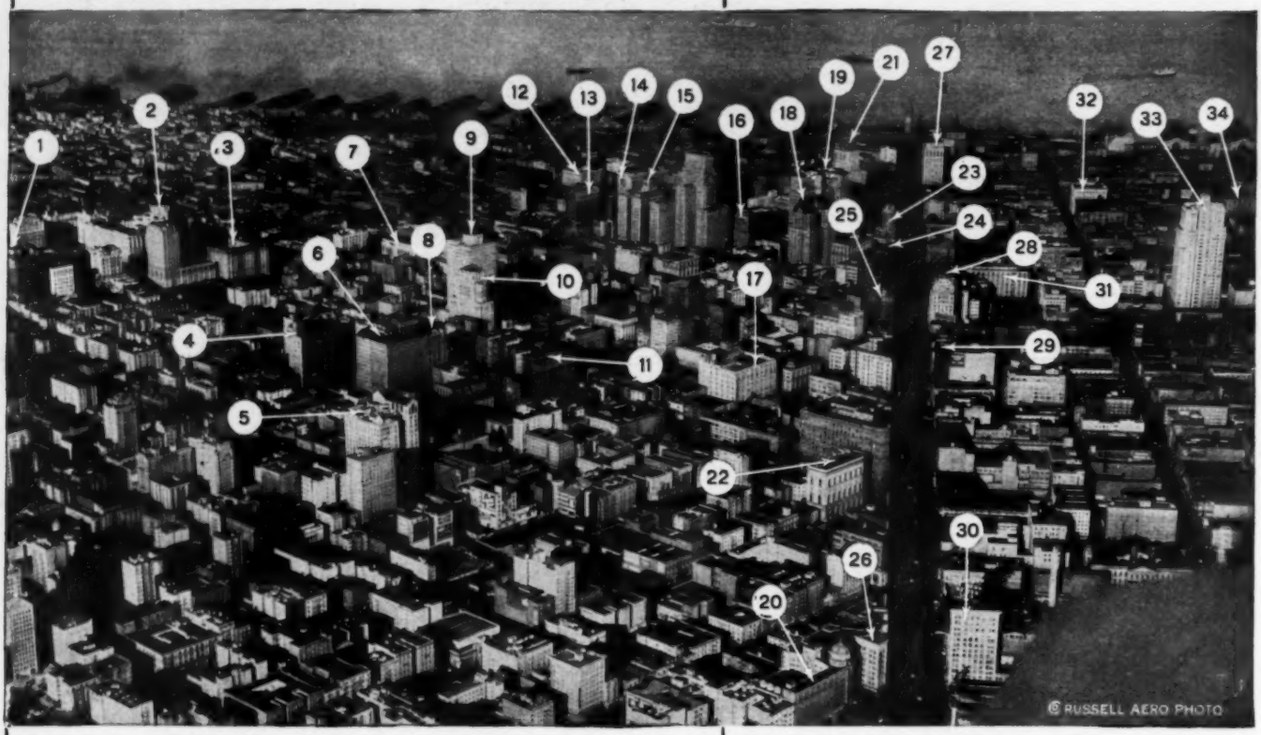

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Heating · Piping and Air Conditioning

Vol. II December, 1930 No. 12

Higher Pressures and Temperatures as They Affect the Design, Installation and Maintenance of Piping

Article No. 1

By J. J. Harman*

During the last decade, steam working pressures have increased spectacularly, after having remained practically fixed for almost a quarter of a century. What this trend has meant, and does mean, to the engineer concerned with the design, the installation and the operation of piping systems is discussed in this article. In this installment, the first of the series, particular attention is directed to the material on the computation of stresses in thick walled cylinders.

AT THE BEGINNING of the Christian era, almost 2,000 years ago, the use of piping was well established, but in spite of its early origin the piping art was still in a very primitive state throughout the world as recently as a hundred years ago, the slow progress being due to lack of development along other lines.

In our country, early in the last century, steam was just beginning to be used for the generation of power and the pressures employed were very low. Strange as it may seem, in the present day when boiler drums for 1,400 pounds steam pressure are made from solid steel forgings with walls 4 inches thick, the boiler shells of the pioneer water works pumping plant at Philadelphia were actually made of wooden planks joined together in the form of rectangular chests, securely bound on the outside. These wooden boiler shells, however, did not give satisfactory service and were soon replaced by shells made of cast iron.

As the 19th century progressed, steam working pressures were gradually increased, and at the beginning of the present century there was a 75-lb. pressure standard which was known as "Medium Pressure" and a 200-lb. pressure standard which was called the "High Pressure Standard." The manufacturers' standard for 250-lb. pressure came into existence in 1901, and in 1914 the American Standard was adopted covering cast iron pipe flanges and flange fitting dimensions for "standard" 125-lb. working steam pressure and "extra heavy" 250-lb. working steam pressure.

* Research engineer, Walworth Company, Boston, Mass.

Past Ten Years Have Seen Spectacular Rise in Pressures

Just previous to 1920 pressures again began to rise and during the past ten years have jumped in a very spectacular manner, after remaining practically fixed for almost a quarter of a century.

Fig. 1 shows in graphic form the rise since 1900 in maximum steam pressures and temperatures and in the use of power driven machinery to supplement the muscular efforts of each individual worker in industry. Our country leads the world in the use of power in industry, which is one of the primary factors in securing our low cost production with high wage scales, and which at the same time has stimulated the development of more efficient power generating equipment, utilizing modern steam cycles and much higher steam pressures and temperatures.

Six Plants Operate in 1200-1400 Lb. Range

There are six central station power plants in this country at the present time operating in the range of

1200 to 1400 lb. working steam pressure at 700 to 750 F, and several others are in the process of design and construction. Nearly a hundred industrial plants employ working steam pressures of 400 lb. or higher, and one industrial plant is being built which will operate at 1,800 lb. pressure and 850 F temperature.

Hydrogenation

A new method of refining crude oil, called hydrogenation, is now being developed which, instead of cracking out the excess carbon atoms from the heavy oil molecule and dropping them in the form of coke or tar, adds the necessary hydrogen to bring the oil molecule to the

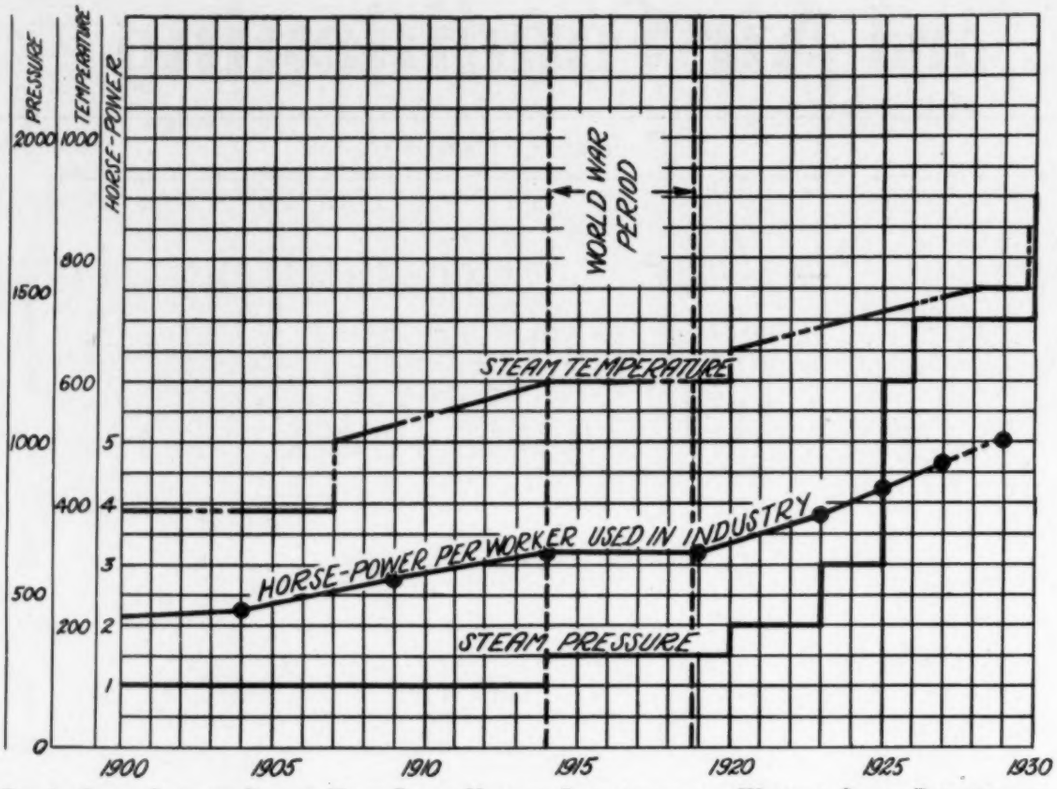


FIG. 1—CHART SHOWING RISE OF HORSE-POWER USED IN INDUSTRY AND OF WORKING STEAM PRESSURE AND TEMPERATURE

Demand for Gasoline Affects Piping

Another feature of our modern national life, which at first thought would not appear to have any connection with high pressure and high temperature piping systems, is the rapid growth of the automobile industry. This phenomenal development in another field of activity has nevertheless created indirectly a demand for piping, valves and fittings to withstand high temperatures and high pressures even greater than that of the power industry.

The enormous increase in the number of automobiles and other gasoline engine driven apparatus in use throughout the country very suddenly placed unheard of demands on the oil industry for more and more gasoline, out of all proportion to the relatively small amount of gasoline yielded by the old methods of refining crude oil. This demand quickly led to the development of new oil refining processes which involved the cracking of the oil molecules to produce a larger percentage of gasoline.

Cracking processes yield 30 per cent to 50 per cent of gasoline from fuel oil after the normal gasoline content of the crude oil has been distilled off, and 50 per cent to 85 per cent of gasoline from light crude oils. Cracking processes commonly use working pressures and temperatures up to 700 lb. at 900 F and in some cases have gone to 1,000 lb. pressure at 1,000 F.

desired composition by the use of high pressures, high temperatures and catalysts. With this new process a 100 per cent yield of gasoline may be achieved, and the formation of coke, for which a ready market is not usually available, is eliminated.

Hydrogenation also makes possible the production of superior grades of lubricating oil from low grade stocks, and provides an effective method of removing sulphur from high sulphur oils. An important feature of this process is that the addition of hydrogen atoms "upgrades" all the products of the process, while the cracking process in removing carbon atoms upgrades a portion of the product, but at the same time produces undesirable products of low value.

Under the present conditions of supply and demand in the petroleum industry it is expected that this process will not displace, but will be used in conjunction with, the existing methods of oil refining. Experimental hydrogenation plants are operating in this country at from 3,000 to 5,000 lb. pressure with the prospect of using even higher pressures.

An unusual patent has been granted in England on a hydrogenation process which contemplates preliminary hydrogenation at pressures of 3,000 to 15,000 lb. and rerun pressures of from 60,000 to 150,000 lb.

The huge development of the oil industry, in addition

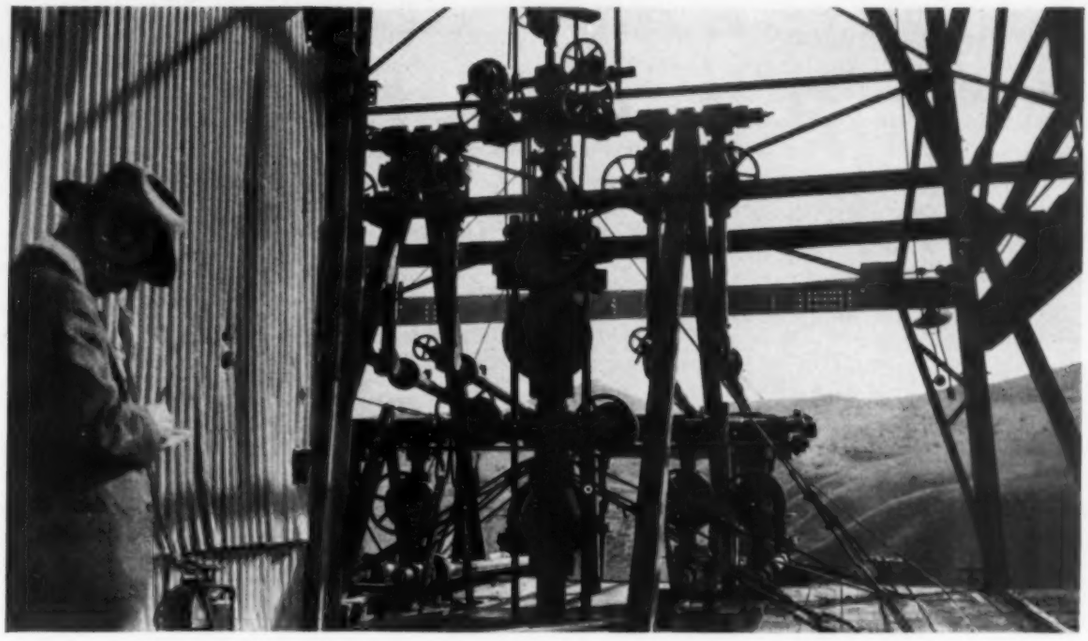


FIG. 2—FRONT VIEW OF "CHRISTMAS TREE" ON HIGH PRESSURE OIL WELL

to the oil refinery requirements, has also led to the extensive use of pressures up to 800 lb. in the oil transportation division for cross-country oil and gas pipe lines, and in the oil producing division deeper drilling, going down almost two miles into the earth's crust, has tapped oil fields having much higher pressures at the casing head, in some cases reaching 3,000 lb. Figs. 2 and 3 show the "Christmas Tree," drilling gates and flow valves on a high pressure oil well.

Atmospheric Nitrogen Industry Uses High Pressures

It would hardly be expected that the prediction of a scarcity in the world supply of wheat, made by Sir William Crookes in 1898, would have any bearing on the demand for high pressure piping, and yet this, too, has had its effect in the development of nitrogenous fertilizers supplied by the atmospheric nitrogen industry which uses extremely high pressures ranging up to 3,000 or 4,000 lb., and in some cases up to 15,000 lb. Similar pressures are used by several other branches of our growing chemical industry, notably those producing synthetic methanol and phenol.

A New Development

This general survey of the unquestionable trend toward higher working pressures and temperatures in industry speaks for itself and manifestly shows that our civilization is entering a new stage in its development, in

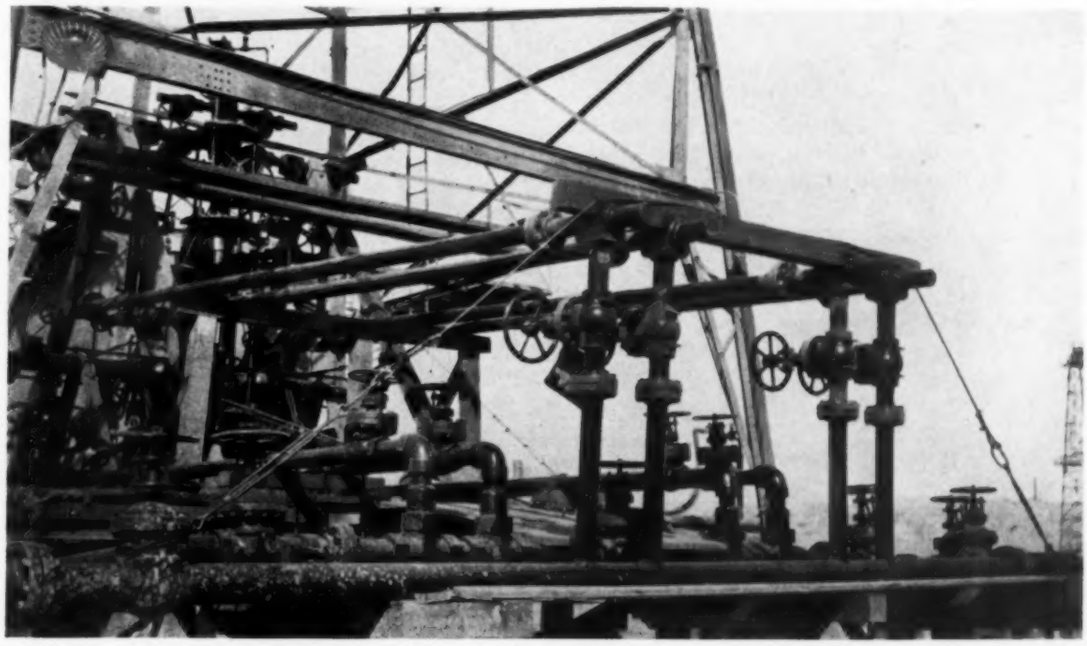


FIG. 3—REAR VIEW OF "CHRISTMAS TREE" AND FLOW LINES ON HIGH PRESSURE OIL WELL

which new processes, methods and materials are being developed to meet new conditions.

The spirit that prompted the burning of witches in Salem has disappeared almost entirely and the old-school viewpoint that stimulated resistance to everything new is changing to active support of progressive developments. Everywhere we see a rising tide of courage to experiment with novel ideas, and the principle of scientific research is being widely adopted.

Effect of High Pressure on Design

When the internal pressure in a piping system is increased without increasing the temperature, it is only necessary to strengthen the walls and joints proportionately so as to maintain an adequate factor of safety, and in general the problems of design are readily handled by the well known principles of mechanics. To be sure, as the walls grow thicker and thicker the simple formulas used for computing the stresses in thin walled cylinders become less and less exact, because the stress is not uniform throughout the wall thickness but is relatively high at the inside surface and low at the outside surface of the cylinder wall.

The common formula for computing the stress in thin cylinder walls is based on the assumption that the unit stress is uniform across the wall thickness and its derivation is readily apparent by referring to Fig. 4. Consider a section of unit length, say one inch, and assume

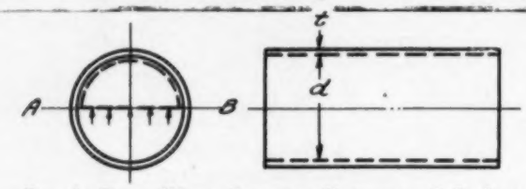


Fig. 4—Thin Wall Cylinder Formula. P Is Internal Pressure in Lb. per Sq. In.; S Is Unit Stress in Lb. per Sq. In.; d Is Inside Diameter in In.; t Is Wall Thickness in In.

$$2\,tS = Pd$$
$$t = Pd/2S$$
$$S = Pd/2t$$

the upper half of the cylinder to be completely filled with an incompressible fluid surrounded by an elastic membrane. Then the total bursting pressure acting at the diameter AB is represented by the expression dP, in which P equals the internal pressure in the cylinder in pounds per square inch, and d equals the inside diameter of the cylinder in inches. The pressure dP is resisted by the stress in the cylinder walls which may be represented by the expression $2tS$, in which t equals the cylinder wall thickness in inches and S equals the unit stress in the cylinder walls in pounds per square inch. We then have the formulas shown in Fig. 4.

Formula for Stress in Thick Walled Cylinder

This simple formula does not give high enough values for S as the cylinder walls become thicker, and numerous investigators have proposed formulas for thick walled cylinders, the most prominent of these being those proposed by Lamé, Barlow, Clavarino and Birnie. Lamé's laws for thick cylinders, developed by the French physicist Prof. Gabriel Lamé in the first half of the 19th century, may be stated as follows:

1) In any section of a cylinder under uniform exterior and interior pressure, the difference between the tangential tension and the radial pressure is the same at all points.

2) In any section of a cylinder under uniform exterior and interior pressures, the sum of the tangential tension and the radial pressure varies inversely as the square of the radius.

Lamé's formula may be expressed as follows:

$$t = \frac{d}{2}\left[\sqrt{\frac{S+P}{S-P}} - 1\right] \text{ or } S = \left[\frac{D^2+d^2}{D^2-d^2}\right]P$$

in which t = thickness of cylinder wall, inches.
d = inside diameter, inches.
D = outside diameter, inches.
S = maximum tangential stress at inside cylinder wall, pounds per square inch.
P = internal pressure, pounds per square inch.

Clavarino's Formula

This formula, however, does not give the true unit stress because Poisson's ratio of lateral contraction was not introduced, and in 1879, A. Clavarino, captain of artillery in the Italian army, published the following formula in the *Giornale d' Artiglieria e Genio* of Rome:

$$t = \frac{d}{2}\left[\sqrt{\frac{S+(1-2m)P}{S-(1+m)P}} - 1\right]$$

$$S = \left[\frac{(1+m)D^2+(1-2m)d^2}{D^2-d^2}\right]P$$

in which t, d, D, S and P are the same as in Lamé's formula and m = Poisson's ratio.

For steel, wrought iron, brass and copper, Poisson's ratio may be taken as 1/3, and for cast iron it may be taken as ¼.

Clavarino's formula then becomes:

For steel, wrought iron, brass and copper:—

$$t = \frac{d}{2}\left[\sqrt{\frac{3S+P}{3S-4P}} - 1\right]$$

$$S = \left[\frac{4D^2+d^2}{3D^2-3d^2}\right]P$$

For cast iron—

$$t = \frac{d}{2}\left[\sqrt{\frac{4S+2P}{4S-5P}} - 1\right]$$

$$S = \left[\frac{5D^2+2d^2}{4D^2-4d^2}\right]P$$

Clavarino's formula considered the gun barrel as a closed end cylinder in which the walls were subjected to longitudinal, as well as bursting stresses. Certainly it would seem offhand that a closed end cylinder having longitudinal stress, in addition to tangential and radial stresses, would develop a higher maximum combined unit stress than an open end cylinder such as we have in the case of gun barrels, but as a matter of fact the combined unit stress for open end cylinders is actually higher. This fact was discovered and Clavarino's fromula modified through the results of extensive experiments on guns which began about 1884 and were conducted by Lieutenant Rogers Birnie, ordnance dept., U. S. A., who later became Chief of Ordnance.

Using the same terms and the same values for Pois-

son's ratio, Birnie's formula may be expressed as follows:

For steel, wrought iron, brass and copper:

$$t = \frac{d}{2}\left[\sqrt{\frac{3S+2P}{3S-4P}} - 1\right]$$

$$S = \left[\frac{4D^2+2d^2}{3D^2-3d^2}\right]P$$

For cast iron:—

$$t = \frac{d}{2}\left[\sqrt{\frac{4S+3P}{4S-5P}} - 1\right]$$

$$S = \left[\frac{5D^2+3d^2}{4D^2-4d^2}\right]P$$

While pipe lines are usually subject to longitudinal stresses, these are greatly affected by expansion and contraction due to temperature changes, and it is more conservative for pipe line computations to use Birnie's open end cylinder formula which gives higher stress values than the closed end cylinder formula of Clavarino. Both of these formulas, however, are rather cumbersome, and while they may be made more readily usable by the aid of charts or graphs, they do not approach in ease of application the simple formula proposed by Prof. Peter Barlow of Woolwich Academy, England, early in the 19th century, which may be expressed in the units previously used as follows:

$$t = \frac{DP}{2S}$$

$$S = \frac{DP}{2t}$$

Barlow's formula may also be expressed in terms of the inside radius r as follows:

$$t = r\frac{P}{S-P}$$

$$S = P\frac{r+t}{t}$$

It will be noted that this formula, as first stated, has exactly the same form as the formula for thin walled cylinders, except that the outside diameter D is substituted for the inside diameter d. This would appear on first thought to be an arbitrary and irrational procedure, but the formula was actually developed on a rational basis starting from the assumption that the metal is incompressible. While Prof. Barlow's original assumption that the metal is incompressible is obviously inaccurate, it is surprising how closely it checks with the more intricate Birnie formula within the range of pressures and pipe sizes usually encountered in practice even in this era of rapidly increasing pressures.

Curves Show Ratios

The curves shown in Fig. 5 show the relation between the two ratios $\frac{P}{S}$ (internal pressure over unit stress) and $\frac{t}{r}$ (cylinder wall thickness over inside radius), as computed by the Barlow and Birnie formulas covering the range up to a $\frac{t}{r}$ ratio of 10; and Fig. 6 shows the same comparison to an enlarged scale over the range up to a $\frac{t}{r}$ ratio of 1.0.

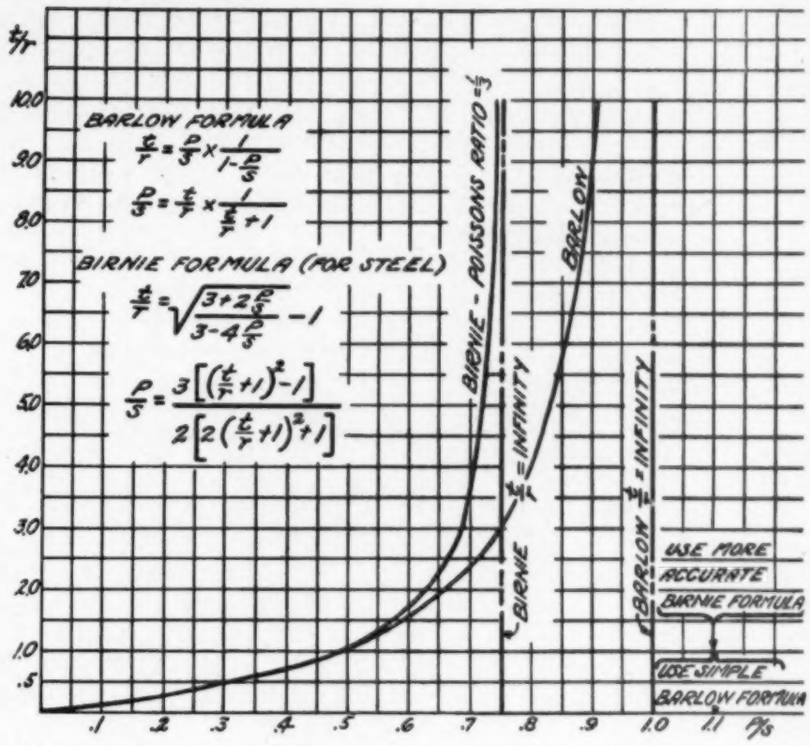


FIG. 5—COMPARISON OF BARLOW AND BIRNIE FORMULAS FOR t/r RATIO UP TO 10

Applying Formulas to Design

A study of these curves reveals some very interesting facts. First, it is evident that for $\frac{P}{S}$ ratios up to ½, the simple Barlow formula gives values practically in agreement with the more accurate Birnie formula, although erring slightly on the side of safety. The small deviation that exists in this range reaches a maximum value of approximately 4 per cent when $\frac{P}{S} = 1/3$ and decreases to zero when $\frac{P}{S} = ½$. For $\frac{P}{S}$ ratios greater than ½, the Barlow and Birnie formulas diverge rapidly, and when $\frac{P}{S}$ equals ¾, the Birnie formula calls for a $\frac{t}{r}$ ratio of infinity, while the Barlow formula calls for a $\frac{t}{r}$ ratio of 3.

The more complex Birnie formula, therefore, finds its

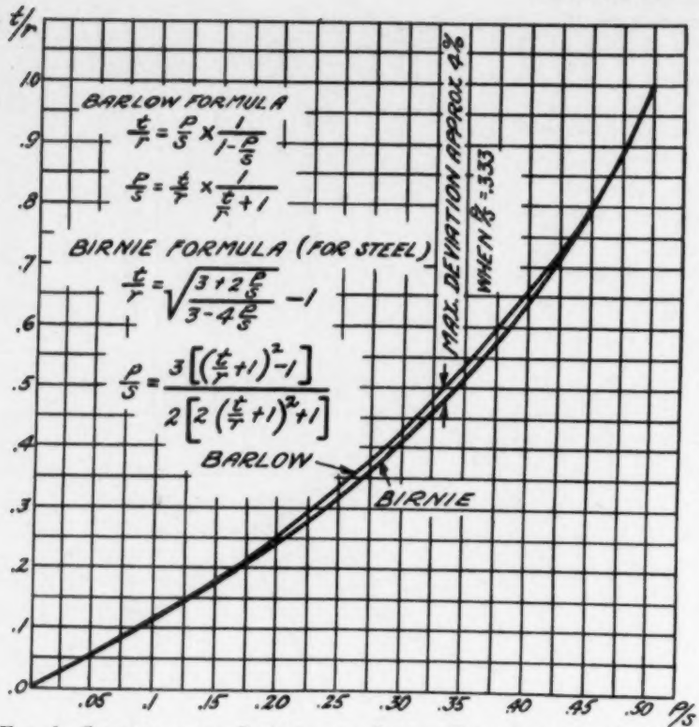


FIG. 6—COMPARISON OF BARLOW AND BIRNIE FORMULAS FOR t/r RATIO UP TO 1.0

$\frac{P}{S}$ economical field of application in the zone where the values exceed ½, and the simple Barlow formula can be used without hesitation for $\frac{P}{S}$ values up to ½, which covers practically all the usual piping problems encountered in industry. In applying this formula to an actual design, however, the computed wall thickness should be increased in order to provide for the normal manufacturing limitations on the control of wall thickness. In the case of steel pipe it is customary to allow for a manufacturing tolerance of plus or minus 12½ per cent of the wall thickness. In the case of iron, brass, or steel castings, a suitable foundry increment is also added to compensate for possible variations in wall thickness due to shifts and surface facings of molds and cores.

Allowances for Manufacturing Limitations

The allowances required to cover manufacturing limitations and tolerances are a factor of increasing importance in determining the proper wall thickness as the pipe diameter decreases, and also in the small pipe sizes the torsional and crushing stresses exerted by the pipe wrench in making up the joints and the longitudinal and bending stresses introduced in service by temperature changes and by external loading of various kinds have an important bearing on the determination of the proper wall thickness. In fact, these two factors combined are in some cases of more importance than the internal pressure in the pipe, and hence the need arose for a modified formula that could be relied upon for general use throughout the full range of pipe sizes in commercial use.

A. S. M. E. Boiler Code Formula

Such a formula was consequently developed in 1924 by the *Boiler Construction Code Committee* of the *American Society of Mechanical Engineers* for computing the maximum allowable working pressures for steam piping of various sizes and wall thicknesses at a temperature of 750 F. This formula is a modification of Barlow's formula and is extensively used in this country. Due to the greater effect in the smaller pipe sizes of factors other than internal pressure, the boiler code formula is really two formulas; one applying to pipes ¼ in. to 5 in. inclusive, and the other to pipes larger than 5 in.

Boiler Code Formula:—

$$P=\frac{2S}{D}(t-0.065)-125$$ for pipes ¼ in. to 5 in., inc.

$$P=\frac{2S}{D}(t-0.1)$$ for pipes larger than 5 in.

Where P = working pressure, pounds per square inch.
t = wall thickness of pipe, inches.
D = outside diameter of pipe, inches.
S = 7,000 pounds per square inch.

These formulas were used in computing the wall thicknesses of American Standard cast steel fittings which were established for pressures up to 1,350 pounds per square inch by the Tentative American Standard for Steel Pipe Flanges and Flanged Fittings, B-16E-1927. In setting up the standard wall thicknesses, however, 50 per cent was added to the computed wall thickness to compensate for the inefficient† shape of the fittings.

Use Modified Formulas With Caution

Modified formulas should always be used with caution and within the range for which they were intended to be used. The modified Barlow formula of the Boiler Code Committee for the larger pipes adds 0.1 inch to the computed wall thickness, but it should be borne in mind that it adds this to the inside of the pipe, which is a very different thing from adding it to the outside, and when we also add the mill tolerance to the inside of the pipe the effect is really much greater than would be anticipated at first thought.

Fig. 7 is introduced to show how the modified Barlow formula, with a mill tolerance of minus 12½ per cent on the pipe, compares with the regular Barlow formula. It should be pointed out, however, that the large increases in wall thickness called for by the modified Barlow formula as shown in Fig. 7 are due largely to the 12½ per cent allowance for mill tolerance, which, by the way, was not incorporated in the Boiler Code formulas, but is now being rather extensively introduced in applying the formulas. While the 12½ per cent allowance is doubtless a reasonable addition for the smaller sizes of pipe where the theoretical wall thicknesses are small, it is obviously entirely too large an allowance as the pipe walls become progressively thicker. For this reason it is usually better, when computing the wall thickness of large pipes for high pressure service, to use the regular Barlow formula and add a suitable increment to cover manufacturing limitations.

†See footnote at end of article.

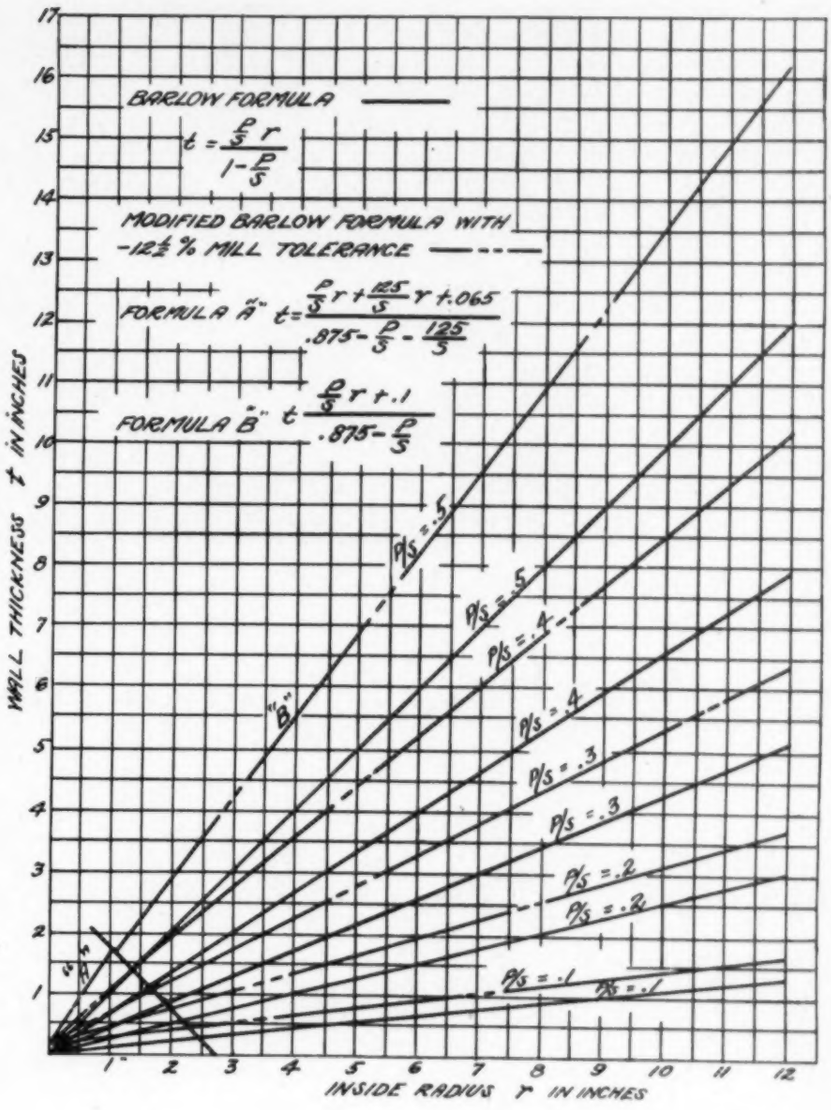

BARLOW FORMULA
$t = \frac{\frac{P}{S} r}{1 - \frac{P}{S}}$
MODIFIED BARLOW FORMULA WITH -12½% MILL TOLERANCE
FORMULA "A" $t = \frac{\frac{P}{S} r + \frac{125}{S} r + .065}{.875 - \frac{P}{S} - \frac{125}{S}}$
FORMULA "B" $t \frac{\frac{P}{S} r + .1}{.875 - \frac{P}{S}}$
WALL THICKNESS t IN INCHES
INSIDE RADIUS r IN INCHES
P/S = .5
P/S = .5
P/S = .4
P/S = .4
P/S = .3
P/S = .3
P/S = .2
P/S = .2
P/S = .1
P/S = .1
"B"
45°

Fig. 7—Comparison of Barlow and Modified Barlow Formulas

Effect of High Pressure on Wall Thickness Shown Graphically

The marked effect of high pressures on the wall thicknesses required for piping, valves and fittings, and the need for higher strength metals as the pressures increase are clearly indicated by the curves shown in Fig. 5. It will be noted that for a $\frac{t}{r}$ ratio of 1, the $\frac{P}{S}$ ratio equals 0.5, and that any further gain in the $\frac{P}{S}$ ratio can only be secured by using much larger $\frac{t}{r}$ ratios. The Birnie formula, which should be used for $\frac{t}{r}$ ratios greater than 1.0, gives a $\frac{P}{S}$ ratio of 0.632 when the wall thickness is increased to double the inside radius, and when it is made four times the inside radius the $\frac{P}{S}$ ratio is increased to only 0.706. It is therefore apparent that little is to be gained by making the wall thickness greater than the inside radius of the cylinder, and increasing it beyond two times the inside radius adds practically no strength as the $\frac{P}{S}$ ratio is only 0.75 when the pipe wall is made infinitely thick.

Working Pressures for Ordinary Metals

Assuming a maximum economical $\frac{t}{r}$ ratio of 1.0, it is interesting to note the maximum working pressures to which the ordinary metals used in the construction of piping, valves and fittings can be applied based on safety factors of 10 for cast iron and semi-steel, 8 for malleable iron, and 6 for bronze, steel pipe and cast carbon steel.

The allowable working stresses shown below are for working temperatures at or near the ordinary range of air temperatures. For elevated working temperatures the allowable working stresses, of course, would be considerably less, and this phase of the subject will be discussed later in this article. For economically handling higher pressures at moderate temperatures, heat treated carbon steels or heat treated alloy steels would appear to be indicated.

Material	Ultimate Strength in Lb.	Working Stress in Lb.	Maximum Internal Press. in Lb.
Cast Iron	21,000	2,000	1,000
Semi-steel	30,000	3,000	1,500
Bronze	30,000	5,000	2,500
Malleable Iron	43,000	5,400	2,700
O. H. Steel Pipe	45,000	7,500	3,800
Med. Carbon Seamless	62,000	10,300	5,200
Cast Carbon Steel, Annealed	70,000	12,000	6,000

The second part of this article will appear in an early issue.

†This substantial addition to the computed wall thickness is necessary because valves and fittings, in which a portion of the metal in the wall is removed in order to provide the bonnet or branch connections, are not as strong as a straight, continuous cylinder. Extensive bursting tests of conventional type fittings, such as elbows and tees, have shown that the average additional wall thickness required to compensate for the inefficient shape of the fittings is approximately 50 per cent. Tees are somewhat weaker structurally than elbows, crosses are weaker than tees and laterals are weaker still because the original cylinder wall is progressively weakened in each of these various types of fittings.

SOUND INSULATION IN A NEWSPAPER COMPOSING ROOM

Control of Sound in Buildings

By F. R. Watson*

WITHIN the past ten years, there has been an insistent and growing demand for the control of sound in buildings and for the reduction of noise. The recent appointment of a noise abatement commission in New York City is an indication of the determination of the public to secure more quiet conditions. Not only is noise detrimental to the efficiency and health of people, but there is evidence to show that accidents are more prevalent under noisy conditions than when quiet prevails.

Evil Effects of Noise

The following quotation[1] from Mr. Shirley W. Wynne, Health Commissioner of New York City, exemplifies the problem of noise in cities.

"Just why the Department of Health came to pick upon the problem of noise abatement may puzzle you who are accustomed to looking upon it as an engineering problem. As a matter of fact, the Department of Health did not seek out the problem; the problem sought out the department. Over a period of years people have been writing us to ask our aid in abating the noises that bother them. Theirs was a practical problem—how to get their proper sleep and how to be efficient on their jobs in the midst of the modern phenomenon of city noise. With instinctive logic they turned to the Department of Health to help them get rid of conditions that materially affected their well-being. From householders disturbed by factory noise or traffic noise or drilling or riveting, from men and women disturbed by stentorian radio concerts in neighboring apartments, from school principals who found their year's work slowed up by the interference of street noise that penetrated into class rooms, from the dean of a woman's college who complained that the class rooms facing on the street had become practically useless, from business offices, from settlement houses, these letters came. We employed a sort of pinch-hitting diplomacy to bring about peace in most of these instances. But the great fact of city-wide noise persists. It is doubtful, however, that these people even suspect how much noise affects them in their daily lives. Physicians from the earliest times have known that noise works hardship on invalids and convalescents. In this city of seven million persons there are many who are ill, many children, aged men and women, those who are not properly nourished, those who are exposed to particularly hazardous occupations, and it is a physician's first thought that noise might in many cases be the straw that breaks the camel's back, the determining factor of physical—and even of mental—health."

Incorrect Ideas About Sound

Along with this public demand for quiet, a number of scientific investigations of the action of sound have been undertaken, so that a considerable amount of information is now available for guidance in the reduction of noise. It is fortunate that scientists have turned their attention to the solution of these problems, because mistakes have grown up due to the popular belief that sound acts in a curious and mysterious way. For example, many people think the efficient cure for the acoustic defects in a room is to stretch wires, whereas this device has repeatedly been tried and found useless.

A second mistake about sound is exemplified by the

* Professor of Experimental Physics, University of Illinois.
[1] Journal of the Acoustical Society, July, 1930.

common saying among fishermen, "Don't talk or you'll scare the fish," whereas the scientific fact is that sounds in air are almost perfectly reflected from the surface of water. It is true that fish are scared when people talk, but this is due to scraping of feet on the bottom of the boat, which gives a sound that passes easily into the water. The writer had opportunity when fishing one summer to test this phenomenon. Loud shouting did not disturb the fish nearby, but the slightest scratch on the boat caused them to scurry away.

Two Acoustic Problems in Buildings

There are two principal problems for the control of sound in buildings—the adjustment of rooms so that the generation of sound and listening conditions are satisfactory, and second, the construction of sound-proof walls and floors to minimize the transfer of sound. The first problem is more completely solved than the second, so that it is now possible to adjust offices and auditoriums for satisfactory acoustics, but there are still some final questions about perfect conditions for concert halls, talking motion picture theaters and auditoriums in general. The question of sound-insulation, on the other hand, is not nearly so well understood. A brick wall, eight inches thick, will stop most sounds, but such a construction is not commonly used in apartments and office buildings; with the result that efforts are now being made to find efficient partitions that are as thin as possible, with a corresponding reduction in weight and expense.

Transmission of Sound

The passage of sound from one room to another is a complicated matter. Consider a radio loud-speaker, for example, that sends out sound waves that are made up of a complex series of compressions and rarefactions. These arrive at a wall and may be transmitted in three ways. If there are any air passages, such as ventilators, threshold openings of doors, or cracks around windows, the waves pass through with practically no hindrance, and it is then a waste of effort to consider making the wall sound-proof unless these air passages are controlled. Second, the compressions and rarefactions of the sound waves may be communicated to the particles of the wall and thus, in turn, to the air on the further side; but experience shows that only a little sound is transmitted in this manner. The third means of transfer is a bodily vibration of the wall, by which the entire partition, or segments of it, move back and forth under the action of the compressions and rarefactions and set up sound waves on the further side. These vibrations, it should be remarked, are usually very small, in the neighborhood of one-twenty five hundredths of an inch or less, but the resulting sound is readily perceived by the ear, which is remarkably sensitive to small sounds.

Mass and Stiffness of Walls

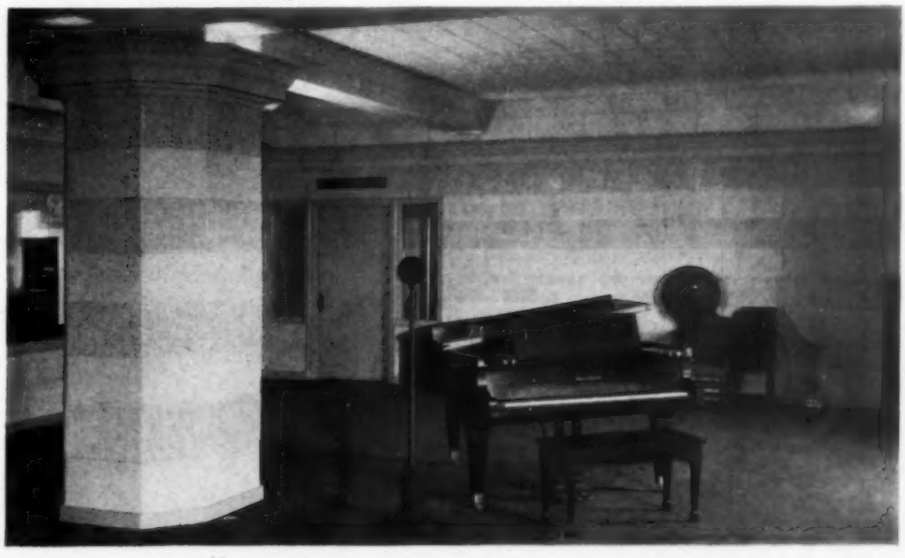
For effectiveness in stopping sound, the mass of a partition is the most important factor. The theory for this statement is given by advanced mathematics[2], by which it may be shown that if the frequency of the incident sound is high compared with the natural frequency of the wall, there is but little sound transmitted by a massive wall; but if the frequency of the incident sound is low, the stiffness of the wall is the controlling factor. Since, however, a massive wall is usually stiff, it means that the mass is the essential quality. A steel wall one-fourth to one-half inch thick, would thus appear to be an effective sound insulator, provided there were no air cracks. A person trapped in a steel safe with tight closing doors would have practically no chance of being heard outside.

Effect of Heating and Air Conditioning on Acoustics

Since air is the medium that conducts sound to the ear, the effects of heat and air currents must obviously be considered. Hot stoves and radiators affect the acoustics because the resulting hot air refracts and reflects the sound waves. A hot stove or an ascending current of hot air in the middle of a room will cut off sound. (See Fig. 1.)

Sabine describes a court room, where ascending air currents from a hot stove made it impossible for auditors at the rear of the room to understand the judge. In the summer time, when the stove was not in use, the difficulty disappeared. For the reason just described, radiators should be located against the walls, and ventilation currents should be broken up in small units so as to leave

[2] Lamb, Dynamical Theory of Sound, Section 9.



A Broadcasting Studio Treated with Insulation

the air in the room as homogeneous as possible. Some years ago, the writer investigated[8] the possibility of using heated currents to control the sound in a room. For example, a sheet of air, heated 27.3 degrees Centigrade above the surroundings and moving obliquely upward from the stage toward the rear of the room, would give increasing reflection when the angle of incidence of the sound was 50 degrees or more. Theoretically, total reflection of sound from this heated current of air would take place when the angle of incidence of the sound was 72° 30′, or more. This means that the incident sound must strike very obliquely against this air sheet to be affected.

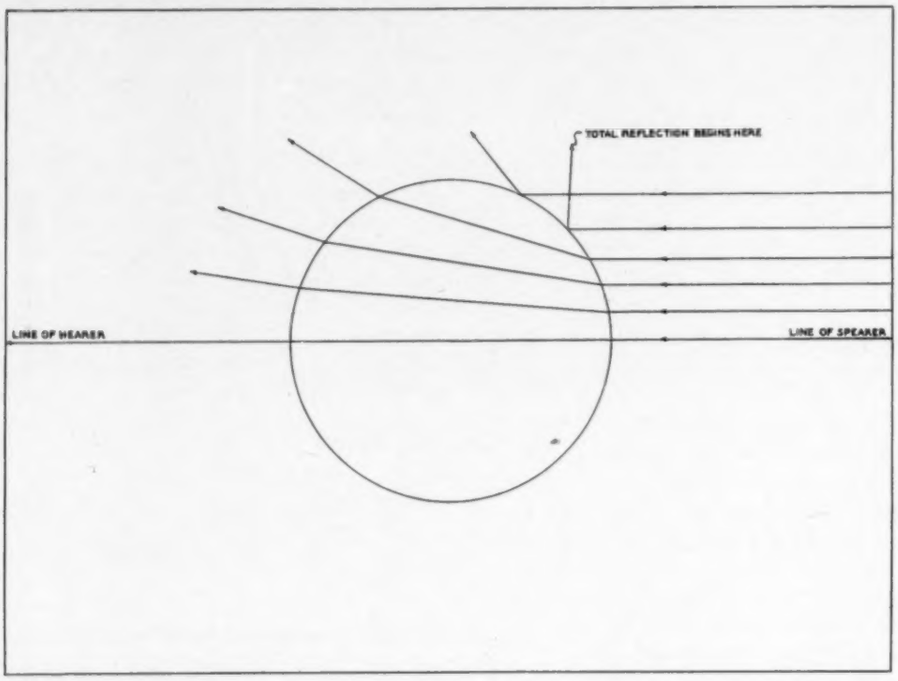


FIG. 1—SHOWING HOW A CURRENT OF HOT AIR REFLECTS AND REFRACTS SOUND WAVES

Fig. 2 shows the effect on sound of a heated air stream and Fig. 3 pictures the effect of a warm, moist air current, with carbon dioxide gas in the room from the breathing of auditors.

The general conclusion drawn from this investigation was that the usual ventilation of a room is not likely to help the acoustics, but is more likely to be a detriment unless it is controlled so as to leave the air as homogeneous as possible. Recent investigations, however, bring out the interesting fact that some electric ionization takes place in the air when sound waves pass, which is complicated by the presence of carbon dioxide. It may be in the future that sound may be influenced by a suitable arrangement of the ventilation.

[8] Air Currents and Their Relation to the Acoustical Properties of Rooms. Engineering Record, 67:265 (1913).

Control of Sound in Ventilation Ducts

Ventilation ducts act like speaking tubes, and thus carry sounds easily from one part of a building to another. The problem is to stop the sound waves and yet allow free motion for the air currents.

The solution of this problem lies in the realization that sound waves act differently from the air currents. As already explained, the sound waves are a series of compressions and rarefactions that move forward in the air with a minute back and forth motion of the air particles, whereas the air current is a bodily movement

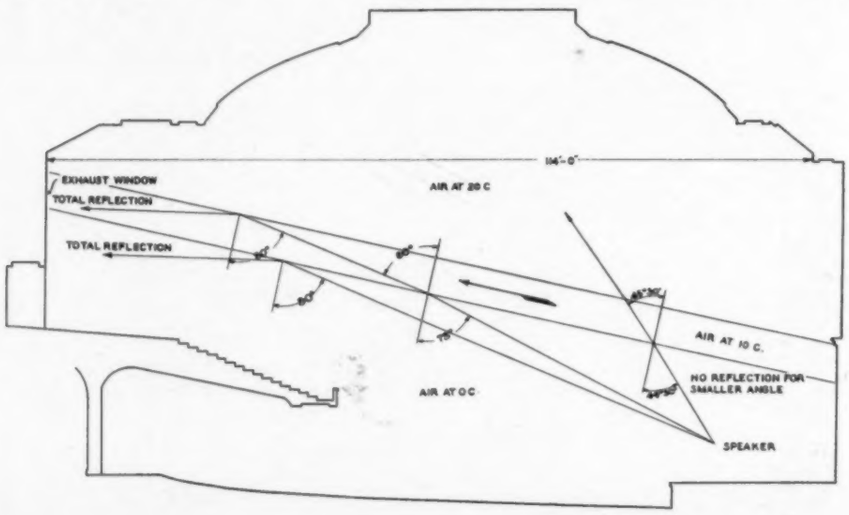


FIG. 2—HOW SOUND IS AFFECTED BY A CURRENT OF AIR TEN DEGREES WARMER THAN THE SURROUNDING AIR

of the air in the forward direction. A baffle in a tube would thus allow the air current to pass around it, but would tend to reflect the sound waves. Any device that acts so as to reflect or absorb the sound waves, and yet which will allow the air free passage, will be effective. The objection to any sort of baffle is that it reduces the flow of air.

Control of Ventilation in Music Buildings

In one building, serious acoustic trouble was experienced because of the ventilation system, in which large supply ducts conveyed air to the separate rooms by means of smaller branches.[4] Sound generated in any one room passed easily through the pipes around to adjacent rooms, and less easily to more distant rooms. Baffle plates and spreader stops at the outlets had little effect in reducing the transmitted sound. It was possible in one location to carry on a conversation easily between a studio on the ground floor and a lecture room on the third floor. No arrangement of baffles stopped this sound, and finally the duct to the lecture room was closed completely.

A further serious complaint was made against the sound from practice rooms in the attic. In this case the sound passed upward through vent pipes to a common exhaust chamber, where it turned and passed down through ducts to the first floor. Inverted metal "baskets," lined with insulating material, were placed over the outlets to these pipes and satisfactorily reduced this disturbance.

Sound Controlled by Long, Narrow Ventilation Ducts

In a second building, the ventilation gave practically no trouble. Long, individual ducts carried air from the plenum chamber to each room, without the usual larger supply duct. Each of these small ducts was insulated from the others by wrapping it with absorbing material. This arrangement made it necessary for sound to travel the entire distance to the plenum chamber before it had opportunity to enter other ducts leading to other rooms, so that the sound waves were dissipated and became too weak to be noticed.

[4] Soundproofing a Building. Arch. Forum, 35:178-182 (1921).

How Much Transmitted Sound Is Allowable in Buildings?

One important consideration in sound-proofing is the amount of reduction of sound needed for the particular case. For example, in music buildings, a musician in one studio will not notice the sounds from adjoining rooms if he is playing; it is only when he stops that he notices the transmitted sound. The same conclusion is true in apartments where a certain amount of sound is not only permissible, but is desirable for comfort. But there are certain cases, as in talking motion picture studios, where absolute quiet is sought. Extreme measures are then taken to stop extraneous sounds. The walls are made massive with highly efficient sound-absorbing lining, and the air conditioning system is carefully equipped with special devices to reduce any sound waves.

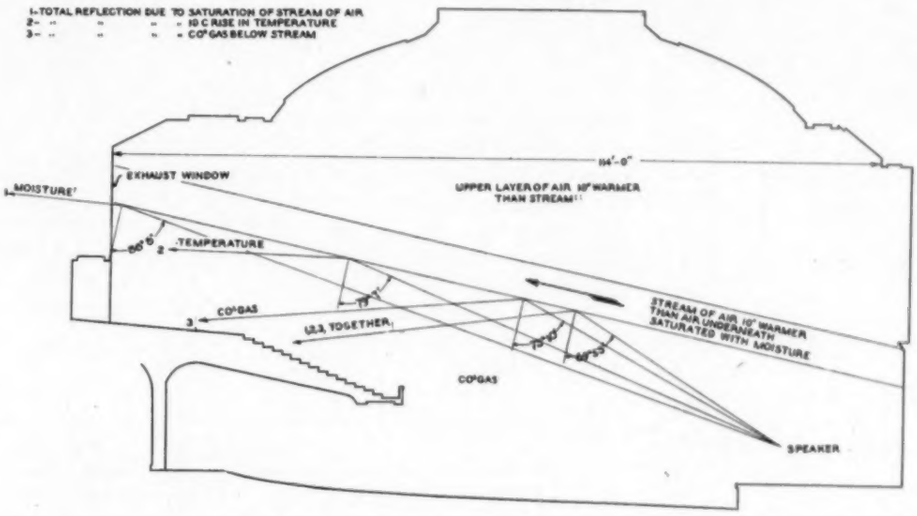

1-TOTAL REFLECTION DUE TO SATURATION OF STREAM OF AIR
2- " " " " 10 C RISE IN TEMPERATURE
3- " " " " CO² GAS BELOW STREAM
EXHAUST WINDOW
MOISTURE
UPPER LAYER OF AIR 10° WARMER THAN STREAM
TEMPERATURE
CO² GAS
1,2,3 TOGETHER
STREAM OF AIR 10° WARMER THAN AIR UNDERNEATH SATURATED WITH MOISTURE
CO² GAS
SPEAKER

FIG. 3—HOW SOUND IS AFFECTED BY A CURRENT OF WARM, MOIST AIR WITH CARBON DIOXIDE GAS IN THE ROOM

Vibrations by Machinery

A source of annoying vibrations and noise in buildings is found in unbalanced motors and machinery. These instruments usually make an intimate contact with the floor so that the resulting vibrations travel easily through the building structure and set up disturbances in any wall, floor, or other construction having the proper frequency. It is better to minimize these vibrations at the source than to attempt to stop them after they get started. That is, the machine itself should be well balanced and as free from vibration as possible. Methods are now available for adjusting machines so as to balance them.[5] As an aid in reducing vibrations, it is desirable to introduce some sort of padding under the base of the machine, such as layers of cork and similar material, steel springs and other devices. It is not easy to prescribe the type of padding because the resulting vibration is complex, depending on several factors—the mass of the machine and its frequency, the elastic constants of the padding, and the type of floor.

In one case, a motor-generator was easily insulated by one layer of fiber board where the floor was thick concrete; in another case a similar motor-generator on a wood floor was not satisfactorily controlled even with

[5] Alec. B. Eason. "The Prevention of Vibration and Noise."

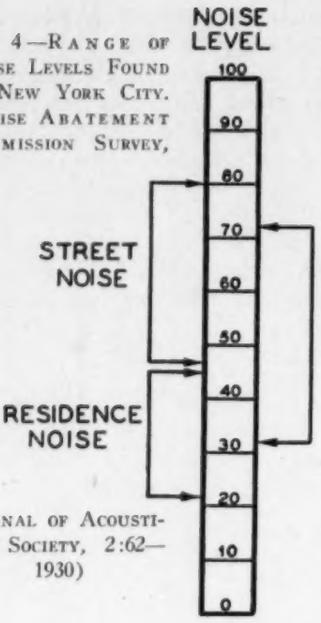


FIG. 4—RANGE OF NOISE LEVELS FOUND IN NEW YORK CITY. (NOISE ABATEMENT COMMISSION SURVEY, JOURNAL OF ACOUSTICAL SOCIETY, 2:62—1930)

five layers of the same board. A concrete base of some mass is often preferred to other types of structures.

Ventilating machinery is quite likely to create noise. The metal housing about a fan is likely to create a rumble that carries easily through the ventilating ducts. Lining the outside of the metal casing with cork or similar material that makes an intimate contact will reduce the vibrations. Heat insulating felt on the inside of the metal housing is also of help.

Loudness of Sound

The amount of sound reduction in any case is better understood if expressed in terms of modern units of loudness. Many people are confused by the difference between intensity and loudness. For example, a fairly efficient wall in transmitting sound will reduce the intensity one thousand fold. That is, if the intensity of the incident sound is 1,000,000 arbitrary units, the transmitted sound will be 1,000 units, a reduction of one thousand. Actually, however, to the ear, the transmitted sound is half as loud. This is because the ear responds less markedly to loud sounds than faint ones. It is very sensitive to faint sounds, but is equipped with a mechanism that protects it against intense sounds; in other words, it responds to the *logarithm* of the intensity, instead of the intensity.

A sound whose intensity is reduced from 1,000,000 to 1,000 is reduced in loudness from log 1,000,000 to log 1,000, or from 6 to 3. Acoustical engineers express these units as *decibels*, which are 10 times the logarithmic units. That is, in the case of the wall just described the reduction in loudness is from 60 to 30 decibels, a reduction of 30 decibels. Numerical values for various types of walls and floors have been published by different laboratories, and a general discussion of the results has been given.[6]

Loudness of Ordinary Sounds

The loudness of various noises are pictured in Fig. 4, which gives the average effects found by experimental measurements. The zero corresponds to a sound that can just be perceived, while the value 100 stands for a sound that is so loud as to be painful to the ear. Fig. 5 gives a more detailed table, compiled from various sources.

Conclusion

There are two chief acoustic problems in buildings. The acoustics of rooms, including auditorium acoustics and office quieting, has been fairly well perfected so that satisfactory effects are easily obtained. Sound-insulation, however, has not been solved so completely. Experimental and theoretical investigations are being conducted to discover the most efficient soundproof walls and floors; also to ascertain the methods for controlling transfer of sound through ventilating ducts.

[6] Symposium on Scund-Insulation. Jour. of Acoustical Society, 1:175-216 (1930).

NOISE IN BUILDINGS

FROM JOINT D.&R. SUBCOMMITTEE SURVEY-NEW YORK DATA	NOISE LEVEL	DATA FROM OTHER SOURCES	SOURCE
	100		
		BOILER FACTORY	1
SUBWAY-LOCAL STATION WITH EXPRESS PASSING	95		
	90		
	85	SOME FACTORIES ARE AS HIGH AS THIS	2
	80	VERY LOUD RADIO MUSIC IN HOME	4
	75		
NOISIEST NON-RESIDENTIAL BUILDING LOCATION MEASURED	70	STENOGRAPHIC ROOM	3
AVERAGE OF 6 FACTORY LOCATIONS		VERY NOISY RESTAURANT	4
	65		
	60		
INFORMATION BOOTH IN LARGE RAILWAY STATION		NOISY OFFICE OR DEPARTMENT STORE	1
	55		
AVERAGE NON-RESIDENTIAL LOCATION	50	MODERATE RESTAURANT CLATTER	4
		FEW PLACES WHERE PEOPLE WORK ARE BELOW THIS	2
		AVERAGE OFFICE	1
NOISIEST RESIDENCE MEASURED	45		
	40	VERY QUIET RADIO IN HOME	4
		QUIET OFFICE	1
	35	SOFT RADIO MUSIC IN APARTMENT	3
QUIETEST NON-RESIDENTIAL LOCATION MEASURED			
AVERAGE RESIDENCE	30		
		COUNTRY RESIDENCE	1
	25	COUNTY COURT, CHICAGO, ROOM EMPTY, WINDOWS CLOSED	2
QUIETEST RESIDENCE MEASURED			
	20	QUIET GARDEN, LONDON	4

SOURCES:
1. H. FLETCHER, "SPEECH AND HEARING", P. 187. MARGINAL AUDIBILITY METHOD WITH 3A AUDIOMETER AND OFFSET RECEIVER. 17 DB. ADDED AS APPROXIMATE FIGURE TO CONVERT TO NOISE LEVEL.
2. D.A. LAIRD, SCIENTIFIC AMERICAN, DEC. 1928, P. 509. BALANCE METHOD WITH 3A AUDIOMETER AND RECEIVER WITH FLAT CAP. APPROXIMATELY EQUAL TO NOISE LEVEL.
3. W. WATERFALL, ENGINEERING NEWS RECORD, JAN. 10, 1927, P. 60. SAME METHOD AS (2) ABOVE.
4. A. H. DAVIS, NATURE, JAN. 11, 1930, P. 48. BALANCE OR MARGINAL AUDIBILITY METHOD WITH 640-CYCLE TUNING-FORK. FIGURES GIVEN IN TERMS OF SENSATION LEVEL, ESTIMATED EQUAL TO NOISE LEVEL.

FIG. 5—NOISES IN BUILDINGS. (JOURNAL OF ACOUSTICAL SOCIETY, 2:63—1930)

BELOW—THE LIBBEY HIGH SCHOOL HAS THREE WATER TUBE BOILERS

BELOW—THERE ARE FOUR HIGH PRESSURE DOWNDRAFT BOILERS IN THE WOODWARD HIGH SCHOOL

CENTER—THE HARVARD ELEMENTARY SCHOOL HAS THREE DOWN DRAFT FIREBOX BOILERS OPERATED AT ABOUT 50 LB.

Fuel Consumption in Toledo Schools

By Samuel R. Lewis*

There is a cumulative as well as a present value in information such as is given in this article. The more there is of it the more valuable it becomes.

In data on one group of schools as reported here, there may be many elusive factors as the author suggests, but the greater the number of the schools and the heating seasons involved, the less prominent will these elusive factors become.

If one finds a certain condition common to, say, 10,000 schools over a period of ten years, while other factors are varied, he may reasonably come to some conclusion as to the cause, which would not be possible if the report is confined to a few schools and one or two seasons.

But inadequate as reports on a single group of schools may be, authoritative statements of this kind are important and add to the value of data already published. So this article is of value not only on its own account but also because it may be co-ordinated with published and future data.

THIS article is accompanied by a tabulation of the older Toledo schools showing their relative sizes and giving the fuel consumption in tons for a five-year average, and in tons for each 1,000 cu. ft. of contents in each building.

There are four general types of heating and ventilating used in the Toledo schools, as follows:

Type A. An all-blast steam system, using steam engine-driven supply fans, with indirect radiation at the flue bases in walk-through concrete tunnels. Each room has a separate mixing damper controlled by a thermostat. There are electric-driven exhaust fans for toilets, cafeterias, lockers, chemical laboratories, etc. The vacuum and boiler feed pumps are steam-driven. Exhaust steam from the main engine and the pumps is all condensed. There are very few direct radiators, heating being all-blast.

Recirculation of the air prior to arrival of the pupils is arranged for.

Type B. This is a system similar to that described above as "A" except that fans and pumps are driven by purchased electricity.

Type C. This consists of heating and direct radiation in each classroom, with air for ventilation purposes delivered to all of the rooms at the same temperature. The control of room temperature is by thermostatic operation of the supply valves on the radiators.

Control of air temperature is by a thermostat in the main air supply duct.

This is a split system.

There are two buildings in the course of construction which have modified split systems with slot-inlets for air supply at the floors along the outside walls; the radiators being placed above the slots so that the incoming air is blown around them.

*Consulting engineer, Chicago, Ill.

Type D. These are gravity warm air furnace systems. They are very old, but give the maximum of ventilation possible without fans, using large heavy cast iron furnaces, each of which supplies not more than two classrooms.

We all know very well that the human element enters into matters of relative coal consumption in school buildings. High schools also often are kept warm many more hours than grade schools. Some buildings are exposed on hill tops, while others are in valleys or may be protected by adjacent buildings and trees in built-up neighborhoods.

However, we find the group of largest buildings, which happened to have water tube boilers because they were so large, running most economically if we use a cubage measuring stick. But only when we have a large number of examples to weigh, and when we consider averages rather than individual cases, can we draw conclusions fairly.

The water-tube boiler group (*a*1) averages .283 tons of coal per thousand cubic feet per season.

The Scott and the Waite buildings, which are duplicates, check exceedingly closely, burning, on a five-year average, 857 and 872 tons of coal per year respectively.

The Scott High School is the most economical of the high schools, and comes very near being the most economical of all the schools. This efficiency is attributed to an exceptionally careful and skillful chief engineer.

The hand stokers, which are, essentially, inclined shaking grates, were used for new plants installed around ten years ago. Eight large buildings (*a*3) having these, with horizontal return tubular boilers and equipment otherwise the same as eight other buildings (*a*2), equipped with level shaking grates, show an average consumption of .295 tons per thousand cubic feet, compared with .306 for the buildings equipped with the level grates.

The boilers which have hand stokers all have more distance from the grates to the boilers, and considerably greater combustion chamber cubage than those which have level grates, and we believe that the lower coal requirement of the hand stokers is due to this better condition.

The smoke record, under high ratings, of the hand stokers does not compare favorably with that of the flat shaking grates.

The down draft boiler group of six schools (*a*4) is fairly comparable with the two preceding groups of eight buildings each. The boilers in these six schools operate at around forty pounds pressure, running steam engines for driving fans, and the buildings are large and of modern type. Their fuel consumption rises to .324 compared to .306 for the horizontal tubular boilers; yet there is in this group the Harvard School, which runs at .234, second only to the Hale School of the horizontal tubular boiler group. The Arlington and the Parkland and Birmingham Schools all have down draft boilers of the straight-through type without a second passage through return flues of the products of combustion. If we eliminate these three buildings and use only the plants which have the second-pass type of boilers, the average for the three remaining buildings becomes .278, surpassing all other groups.

We must admit that three buildings are hardly sufficient upon which to declare an average, and that this particular average is unduly affected by the remarkable record of the Harvard School.

TYPE A. ALL BLAST STEAM, WITH STEAM ENGINE POWER

(*a*1) With water tube boilers and shaking grates.	Cubic Feet in Thousands	Tons per Year 5 Yr. Average	Tons per M Cu. Ft.
1. Libbey High	4043	1248	.309
2. Scott High	3500	857	.244
3. Waite High	3500	872	.249
4. Lincoln Grade	1380	426	.308
5. Gunckel Grade	1455	471	.324
6. E. S. Central	972	260	.268
Average of six	.....	.....	.283
(*a*2) With horizontal return tubular boilers and shaking grates.			
1. Cherry Grade	910	296	.326
2. Garfield Grade	977	261	.267
3. Hale Grade	1506	346	.230
4. Navarre Grade	870	273	.314
5. Sherman Grade	1415	496	.351
6. Webster Grade	1433	485	.339
7. Walbridge Grade	1135	408	.360
8. Glenwood Grade	1054	273	.259
Average of eight	.....	.....	.306
(*a*3) With horizontal return tubular boilers and hand stokers.			
1. Franklin	1012	347	.343
2. Hamilton	1502	399	.266
3. Longfellow	1212	394	.325
4. McKinley	1614	437	.270
5. Oakdale	1535	452	.294
6. Riverside	1497	455	.304
7. Whittier	1652	447	.271
8. Lagrange	1216	350	.287
Average of eight	.....	.....	.295
(*a*4) With down-draft firebox boilers and shaking grates.			
1. Jones Jr.	2146	623	.290
2. Arlington	1152	413	.358
3. Harvard	1135	265	.234
4. Raymer	1507	468	.310
5. Birmingham	1130	387	.343
6. Parkland	1136	464	.409
Average of six	.....	.....	.324
(*a*5) With Scotch boilers.			
1. Chase	686	221	.323
2. Wayne	686	199	.291
Average of two	.....	.....	.307

The Chase and the Wayne Schools have Scotch marine boilers with corrugated internal furnaces. They were installed many years ago, with exterior furnaces in masonry dutch ovens, having side-inclined shaking grates. The grates and the ovens gave out, and eventually were removed, and the conventional shaking grates were placed in the restricted interior furnaces. They burn Pocahontas coal without serious smoke-complaint, and the fuel consumption is not excessive, as is shown by the .307 average.

The next older group of eight buildings, *Type B*, was equipped twenty years or more ago with updraft

TYPE B. ALL BLAST STEAM, WITH ELECTRIC POWER WITH UP-DRAFT FIREBOX BOILERS.

	Cubic Feet in Thousands	Tons per Year 5 Yr. Average	Tons per M Cu. Ft.
1. Stickney	649	193	.297
2. Auburndale	670	227	.340
3. Irving	543	150	.278
4. Monroe	416	122	.294
5. Newberry	474	124	.262
6. Newton	423	138	.328
7. Warren	417	126	.304
8. Roosevelt	438	183	.418
Average of eight	.....	.....	.315

TYPE C. SPLIT STEAM, DIRECT RADIATION, ELECTRIC POWER WITH DOWN-DRAFT FIREBOX BOILERS.

	Cubic Feet in Thousands	Tons per Year 5 Yr. Average	Tons per M Cu. Ft.
1. Spring	546	202	.370
2. Indiana	539	196	.364
Average of two	.....	.....	.367

TYPE D. GRAVITY WARM AIR FURNACES.

	Cubic Feet in Thousands	Tons per Year 5 Yr. Average	Tons per M Cu. Ft.
1. Jefferson	510	218	.429
2. Pickett	527	226	.430
3. Segur	473	138	.293
4. South	383	145	.380
5. Washington	537	166	.310
Average of five	.....	.....	.368

brick-encased steel firebox boilers. They all burn Pocahontas coal and all are old buildings of from twelve to sixteen classrooms each. The plants in these buildings have no vacuum systems or pumps, but have the blast radiation in groups at the flue-bases where it replaced the warm air furnaces formerly used.

The Stickney school is the only one of the group in which the present plant is not a replacement of furnaces. The Stickney school was built about 1910, and has updraft firebox boilers and a steam engine for fan driving, and so should strictly not be in the group, but its average of .297 helps the group rather than otherwise.

The Stickney school compares in size with the electrically equipped Auburndale school, but eclipses the latter in coal economy, yet saves the cost of electric energy required at the Auburndale school for fan propulsion.

The human element again manifests itself as we compare the Newberry school and the Newton school, two neighboring old buildings of the same size and age. It is possible that the Newberry school is of a little better character of construction.

The split-system group, *Type C*, covers only a four-year average. These plants are the third in succession to be applied to the two old buildings.

They have sixteen classrooms each, with gravity-circulating steam systems which succeed fan-driven warm air furnace systems which superseded gravity furnace systems. We did not expect that direct radiation split-system plants would compare with all-blast plants in fuel consumption, so we are not disappointed in the average of .367.

Two other old-timers, the Fulton and the Hathaway schools, have split systems, but have been in service only over one heating season.

These plants also are the third ones in both buildings but unlike the systems in the Spring and Indiana schools, have two-pipe steam circulation with electric vacuum pumps.

The one-year record of the modernized Fulton school is .299 and this probably will be reduced for a five-year average.

It will be interesting to compare the record of the Fulton school, having direct radiators and a vacuum system, with that of the Monroe school, a building which has gravity steam circulation and no direct radiators in the classrooms.

The Monroe average for five years is .294, while the unstabilized one-year average of the Fulton school is .299. Apparently there will be a close race, with the ultimate advantage to the Fulton school.

There are a few furnace plants in service. Their fuel consumption is apparently dependent upon the

THE NATHAN HALE SCHOOL IS TYPICAL OF THE MODERN TOLEDO ELEMENTARY SCHOOLS. IT HAS THIRTY-SEVEN CLASS ROOMS, AN AUDITORIUM AND A GYMNASIUM, IN ADDITION TO THE BASEMENT ROOMS, WHICH ARE USED FOR PLAYROOMS, LABORATORIES, ETC. THE HEATING AND VENTILATING PLANT WAS INSTALLED AT A COST OF 9.71 PER CENT OF THE TOTAL COST OF THE BUILDING. THE BOILERS ARE HAND FIRED HORIZONTAL TUBULAR TYPE, WITH STEEL JACKETS

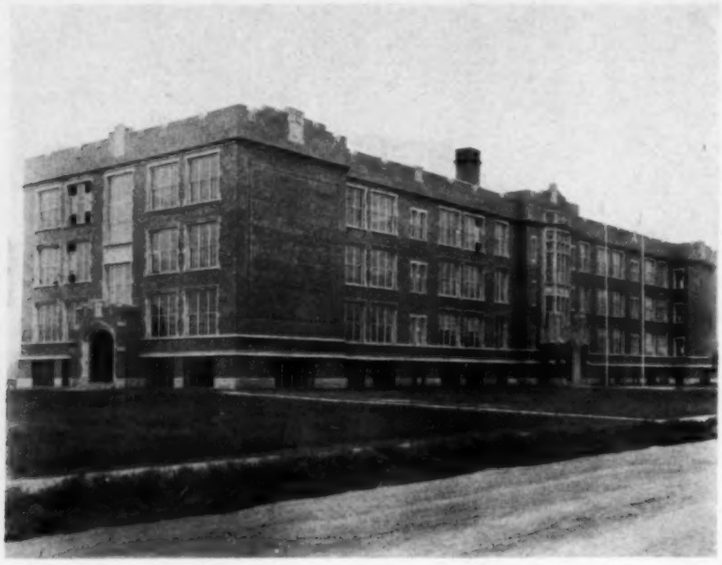
human element, as witness the comparison between the Segur school at .293 and the Pickett school at .430. These buildings are comparable in size and they are located near each other. The average fuel demand of the group is not far from that of the split-system group.

Neither of these two high fuel demand groups have enough members fairly to be averaged.

The later Toledo buildings follow *Type A,* for the larger schools, with electrically-operated automatic stokers, while the smaller ones have down draft firebox boilers with electric power for vacuum pumps and fans.

The Woodward high school, on which we have but one year's record, has down-draft boilers and steam power, and shows .364 tons per thousand cubic feet of space heated. We are not disturbed by this, as the first year's fuel demand of most large plants is excessive, while the operating force learns how to operate the building and how to manipulate the plant.

The Woodward high school has 4,190,000 cubic feet of space, with four boilers. It is the largest completed high school in Toledo, and is only surpassed by the DeVilbiss high school, in course of construction, which is equipped with four stoker-fired horizontal return tubular boilers with exceedingly large combustion chambers and automatic and compensated combustion control. These boilers are designed to operate at up to 200 per cent of rating, and are to burn bituminous screenings.



NAVARRE SCHOOL. THIS 18-CLASS-ROOM BUILDING HAS AN AUDITORIUM AND A GYMNASIUM. IT HAS STEEL JACKETED HORIZONTAL TUBULAR BOILERS

While the buildings of groups *a2* and *a3* nearly all have 72 in. by 18 ft. size boilers, and while their design shows no calculated surplus boiler capacity, only one of the two boilers provided is used in most of the buildings except in some rare emergency.

This suggests that a horizontal return tubular boiler of this large size, given an adequate combustion chamber volume and a fair draft, is capable of exceeding greatly its rated capacity with excellent economy.

In an effort to keep down the excess air in the products of combustion, so often present in brick-encased boilers, all of the brick set boilers of *Type A* in the Toledo schools have tight steel casings outside of the brickwork. These have proved to be very desirable and have well justified their slight additional cost.

The "ABC's of Warm Air Furnace Engineering" is a 48-page, paper-bound book, containing a rather complete explanation of the fundamentals of designing warm air systems for industrial plants, garages, auditoriums, and residences. It is written in a non-technical manner, easily understandable. Several helpful tables of heat transmission factors, duct areas and capacities, etc., are included.

Both forced and gravity circulation are considered by the author, J. C. Miles. The book is presented in the form of lessons; questions scattered throughout its pages allow the student to review his understanding of the subject.

The publishers are the Readers Service Bureau of Warm Air Heating, at 105 S. Ninth st., St. Louis, Mo. The book is sold for $1.00 per copy.

The *National Research Council,* 29 W. 39th St., New York, has published "Five Years of Research in Industry." The compiler, Clarence J. West, director of the research information service, has supplied references to articles which will give the conclusions of America's leaders of research, show the practical results that have been achieved in their laboratories, give their opinion of cooperative research in industry as contrasted with individual effort, and stress the philosophy and method of operation of research laboratories in specific industries.

Among the classifications under which the hundreds of papers listed are divided are corrosion, heating and ventilating, hydraulics, metallurgy, power, refrigeration, steam engineering, and welding. Seventy-eight other classifications refer to numerous specific industries and fields of engineering.

Figuring Pressure and Temperature Drop in a Hot Water Piping System

By P. M. Greenwell

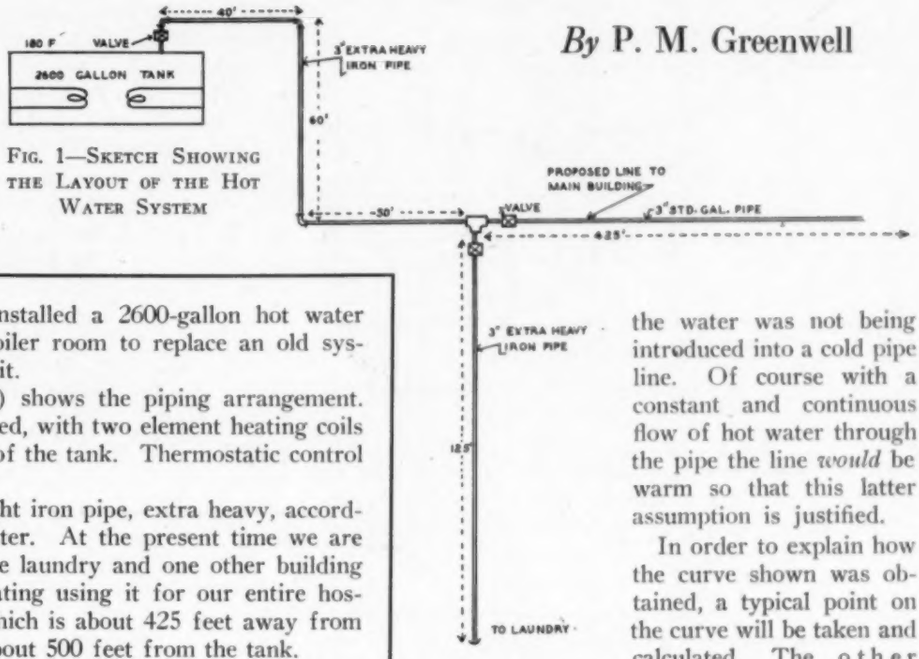


FIG. 1—SKETCH SHOWING THE LAYOUT OF THE HOT WATER SYSTEM

We have recently installed a 2600-gallon hot water storage tank in our boiler room to replace an old system that is ready to quit.

The sketch (Fig. 1) shows the piping arrangement. The tank is steel, unlined, with two element heating coils situated in the bottom of the tank. Thermostatic control gives 180 F at outlet.

We are using wrought iron pipe, extra heavy, according to tests on our water. At the present time we are using the water for the laundry and one other building only but are contemplating using it for our entire hospital and sanitarium which is about 425 feet away from the engine room and about 500 feet from the tank.

Now the question has arisen as to how much drop in temperature we will get at the treatment rooms—also what drop in pressure. We are using 75 lb. on our water system, supplied with a pump.

What size pipe should we use in order to maintain the proper circulation in the lines? The line to the main building will be comparatively straight, with two or three forty-five elbows.—*Horace B. Gardner,* chief engineer, New England Sanitarium and Hospital.

CONCERNING the first question (asking how much drop in temperature will occur in carrying a hot water line from a tank to a hospital building approximately 500 ft. distant) the drop will depend upon two things—first, the rate of flow and, second, the insulation of the line. Of course, if the rate of flow is not maintained, or if the water is allowed to lie stagnant in the line, the temperature drop may reach almost any amount due to the natural cooling of the water held in the pipe. That is, the temperature of the water will fall until it approaches the surrounding temperature, whatever that may be.

The Drop in Temperature

The chart shown in Fig. 2 gives the number of degrees drop which will occur in a 3-in. line approximately 575 ft. long when 180 F water is introduced at one end and is allowed to flow through the pipe in a constant and continuous movement. In calculating this curve, certain assumptions had to be made, such as the minimum outside temperature, insulation used on the pipe, and the fact that the pipe was assumed to be warm; that is that the water was not being introduced into a cold pipe line. Of course with a constant and continuous flow of hot water through the pipe the line *would* be warm so that this latter assumption is justified.

In order to explain how the curve shown was obtained, a typical point on the curve will be taken and calculated. The other points are obtained in a similar manner by means of simply changing the quantity of water assumed to be flowing and re-calculating with this revised amount. For this purpose let the temperature drop for a flow of 100 gallons per minute be considered. The total length of pipe line as shown on the sketch, Fig. 1, is $40+60+50+425=575$ ft. There also is a short branch running into the hot water generator but as no length is given for this branch it has been assumed that it is so short as to be negligible. The pipe line is all 3-in. although some of it is standard weight and some is extra heavy weight; the outside circumference is the same in both cases being over 10 but less than 11 in. To avoid too much exactness in calculating it will be assumed that the pipe is exactly 10 in. in circumference, which would make the outside surface per lineal foot

10 in./12 in. or 5/6 sq. ft.

Then a line 575 lin. ft. in length would have an outside surface on the pipe equal to

$575 \times 5/6$ sq. ft. or 479 sq. ft.

and, as the pipe transfers heat to the surrounding air—when it is bare—of about 3 Btu per degree difference per sq. ft. per hour the total heat emission with water in the pipe at 180 F and an outside temperature of zero would be

479×3 Btu $\times (180-0)$ or 1437×180 or 258,660 Btu

Effect of Insulation

This, however, is for bare pipe and it is assumed that an insulation of reasonable and normal efficiency

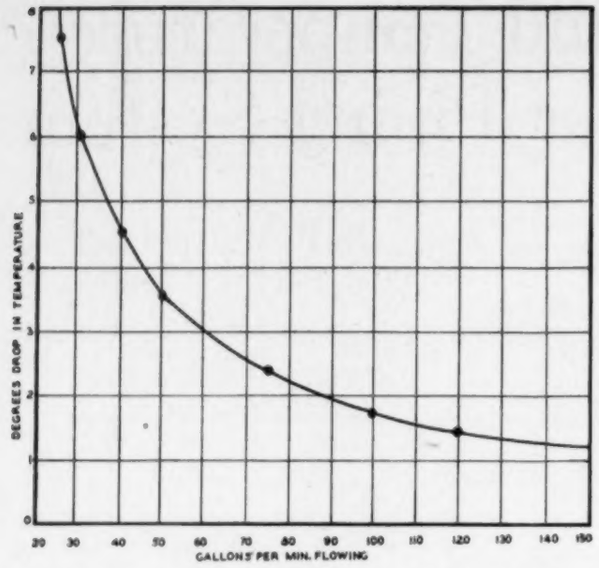


FIG. 2—CURVE SHOWING TEMPERATURE DROP ACCORDING TO QUANTITY OF WATER FLOWING

would be used on the line—say a pipe covering with an efficiency of about 65 per cent which means that 65 per cent of the heat normally radiated from an uncovered line is conserved by the covering and that only 100 per cent minus 65 per cent or 35 per cent is lost from the line after the covering is applied. It is possible to obtain pipe coverings with even higher efficiencies than 65 per cent, but for ordinary conditions probably 65 per cent is a conservative figure to use. Then the actual loss from the covered line would be 258,660 Btu × 35 per cent or 90,531 Btu and this amount of loss will go on regardless of how much of a flow is maintained through the line.

To calculate the temperature drop when 100 g.p.m. is flowing it is necessary to reduce this quantity to pounds of water per hour as the heat loss from the line is stated in Btu per hour. This gives the following:

100 g.p.m. × 8 1/3 lb. × 60 min. or 50,000 lb. (almost)

and, as each pound of water in cooling one degree gives up one Btu the number of degrees that 50,000 lb. will drop is found by dividing the total heat radiated by the number of pounds flowing in one hour or 90,531/50,000 = 1.8 F; and this is what is shown on the curve. By similar method, other points are calculated by assuming other rates of flow and the curve is determined by drawing a line which passes through all of the points. It will be seen by referring to the curve, Fig. 2, that the temperature drop will vary from 1¼ F, when 150 g.p.m. is flowing up to 7½ F, when only 25 g.p.m. is passing through the line. Still lower quantities will give still higher temperature drops until all motion ceases, at which time the water in the line will assume the temperature of the surrounding air if allowed to remain in the line a sufficient length of time.

Pressure Drop in the Line

The second question regarding the drop in pressure will now be considered. The drop in pressure also varies with the flow but in a manner opposite to that occurring for the drop in temperature. In other words, while the drop in temperature decreases as the flow increases, the drop in pressure increases with the increase of the flow. In Fig. 3 a curve has been plotted showing the pressure drop for various amounts flowing from 25 g.p.m. to 150 g.p.m., and it will be seen that the pressure loss runs from 0.7 lb. per sq. in. with 25 g.p.m. flowing up to 20 lb. per sq. in. with 150 g.p.m. flowing. In fact it will be slightly greater than this because part of the line is of extra heavy pipe with a slightly smaller diameter than standard weight. To avoid undue complication only the friction for standard weight pipe has been considered in this article.

To illustrate how the pressure drop curve, Fig. 3 was developed the pressure drop for a flow of 100 g.p.m. will be calculated. It has been found in the calculations already made that the actual length of pipe line is 575 lin. ft. but there are three 90-deg. ells shown on the line and it is stated there will probably be a few more on the run over to the hospital. It will be assumed that there will be a total of about six 90-deg. ells of 3-in. size. It is generally assumed that a 3-in., 90-deg. ell produces a friction equal to about 15 ft. of 3-in. pipe so that the friction length of the line will be the true length plus 90 ft. added friction for 6 ells at 15 ft. each. Then the total friction length will be 575 + 90 = 665 ft. or, say, about 700 ft. for even figures. The tees and valves are neglected as a gate valve produces very little friction and the water does not make a right angle turn in the tee on its way to the main building.

The friction for a flow of 100 g.p.m. must be calculated from friction tables giving the drop for 100 ft. of straight pipe and reference to such tables shows that the drop in 3-in. pipe per 100 ft. of run is 1.31 lb., when 100 g.p.m. is flowing. As there is a friction length in the line of about 700 equivalent feet (as previously calculated) the total drop in the line under consideration will be

1.31 lb. × 700/100 or 9.17 lb., which is the amount shown on the curve, Fig. 3. Other drops may be similarly calculated for other flows and the whole curve thus determined.

Size of Circulation Line

The third question, as the size of return circulation

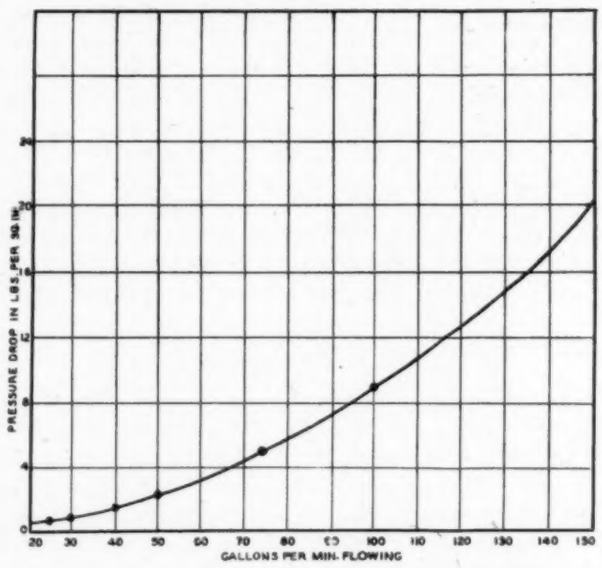


FIG. 3—CURVE SHOWING PRESSURE DROP ACCORDING TO QUANTITY OF WATER FLOWING

line to use makes it appear that gravity circulation is contemplated but this is advised against owing to the long horizontal run which exists. In general, gravity circulaiton is not successful when the length of the horizontal run much exceeds the height of the risers which give the circulation head. What is recommended is the use of a small booster pump to circulate the water to and from the hospital and this pump can be made to circulate any quantity of water desired so that the desired temperature drop will not be exceeded. If a temperature drop of about 8 F is not objectionable it has been shown that a flow of 25 g.p.m. is all that is necessary and the size of the return line need be only sufficient so as not to produce an unreasonably high head on the pump when this quantity of water is flowing.

Reference to friction tables again shows that the head necessary to move 25 g.p.m. through pipes of various sizes for a 700 ft. equivalent length of run approximates the following:

For 3-in pipe	0.7 lb.
2½-in. pipe	1.4 lb.
2-in. pipe	3.5 lb.
1½-in. pipe	18.0 lb.
1¼-in. pipe	44.0 lb.

and a casual inspection of this list indicates that pipe of less size than 2-in. produces an enormous increase in the head on the pump and is therefore not a good or economical proposition in this case.

Taking all of the above into consideration the writer would recommend a 3-in. supply, a 2-in. return and a circulation pump with about 25 g.p.m. capacity against a 15 ft. head to allow for the additional friction in the extra heavy pipe.

New Alignment Chart for Computing the Pressure Drop Due to the Frictional Resistance of a Flowing Fluid

By Temple C. Patton*

IT HAS been pointed out in a recent article[1] that engineers are erroneously employing isothermal data in calculating fluid friction for the heating or cooling of fluids flowing inside pipes. The article contains considerable data on oils, that were obtained in an extensive series of runs under heating and cooling conditions which show that heat transmission has a marked effect on the friction factor. It is the primary purpose of the accompanying chart to represent this effect graphically.

Although the chart covers the entire range for fluid flow, it shows the effect of heating or cooling through the viscous region only. It is interesting to note that heating or cooling seems to have considerably less effect through the turbulent flow range, whereas the smoothness or roughness of the pipe interior is of major importance. The chart has been drawn up to allow for this latter effect through the turbulent flow range, and two separate sets of data[2] have been plotted, each representing an independent compilation of averaged values from various sources.

To compute the pressure drop graphically it is necessary to know the value of five factors, the specific gravity and viscosity of the fluid under consideration, the diameter of the pipe through which it flows, the velocity of fluid flow, and either the type of interior pipe surface if the flow is turbulent or the temperature drop from the pipe temperature to the average temperature of the liquid, if the flow is viscous.

[1] Chem. and Met. Eng., Vol. 36, No. 8, pages 464-467.

[2] "Principles of Chemical Engineering," Walker, Lewis and McAdams, 1927 Ed., page 87, McGraw-Hill Book Co., Inc. HEATING, PIPING AND AIR CONDITIONING, Vol. 1, No. 4, page 275.

* Instructor in Physics, Massachusetts Institute of Technology.

S = Specific Gravity

The specific gravity of a fluid, especially an oil, is commonly expressed in degrees Baumé as determined by the hydrometer test. Conversion from Baumé degrees into specific gravity for liquids lighter than water is usually accomplished by the *American Petroleum Institute* (A.P.I.) scale represented by the formula:

$$\text{Sp. gr.} = \frac{141.5}{131.5 + \text{Baumé degrees}}$$

For liquids heavier than water the conversion is usually accomplished by means of the formula:

$$\text{Sp. gr.} = \frac{145}{145 - \text{Baumé degrees}}$$

V = Velocity

Velocity is expressed as feet per second. The volume of liquid discharging through the pipe expressed as cubic feet per second, can be computed by multiplying the velocity by .0055 times the square of the inside diameter.

D = Inside Diameter of Pipe

The diameter is expressed in inches. A table giving inside pipe diameters for pipes of various sizes and weights is given on page 276, No. 4, Vol. 1 of HEATING, PIPING AND AIR CONDITIONING.

Z = Viscosity

Viscosity is expressed in centipoise units. Since the viscosity of water is 1 at 68 F, the viscosity of a fluid expressed in this system of units is also a relative viscosity. Viscosity is commercially determined by various

types of viscometers, each type having its individual system of units. These systems have been correlated and reduced to a common basis of kinematic viscosity in a conversion diagram to be found on page 33, Vol. I, of the *International Critical Tables*, based on the following formulas used by the *United States Bureau of Standards* in computing kinematic viscosities:

$$\text{For Saybolt viscometer } k = .00220S - \frac{1.80}{S}$$

(S = Saybolt time, secs.).

$$\text{For Engler viscometer } k = .00147E - \frac{3.74}{E}$$

(E = Engler degrees, $\frac{\text{Engler time, secs.}}{51.3}$).

$$\text{For Redwood viscometer } k = .00260R - \frac{1.715}{R}$$

(R = Redwood time, secs.).

$$k = \text{kinematic viscosity} = \frac{\text{poises}}{\text{density in grams/cm.}^3}$$

To convert kinematic viscosity into centipoise units multiply by 100 times the specific gravity of the liquid.

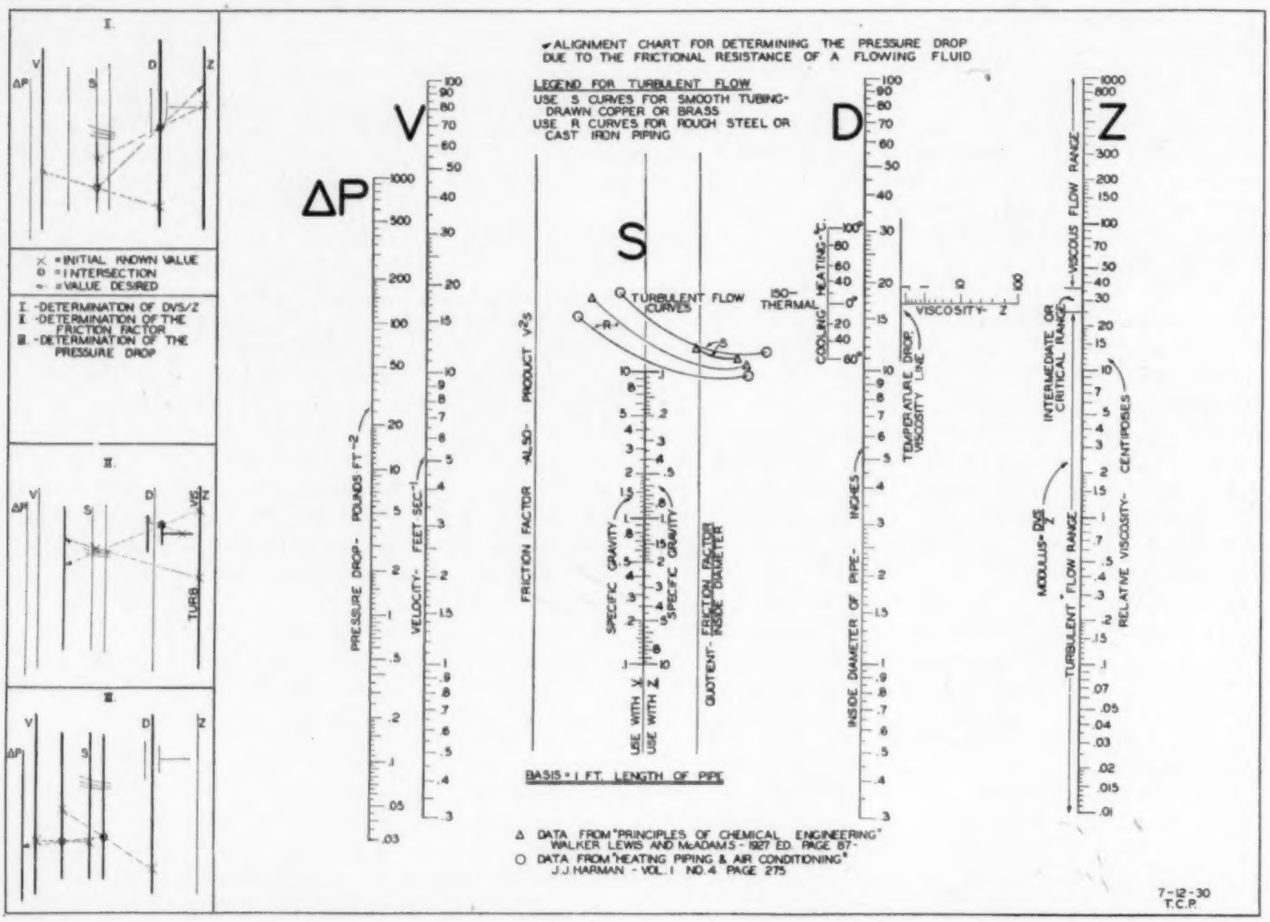
Use of Chart

These four factors detailed above in the form DVS/Z represent a dimensionless modulus, the numerical value of which determines the type of flow which occurs under a given set of conditions.

To locate this modulus value on the chart, first definitely determine and locate the values of D, V, S, and Z on their respective vertical scales (use S on the right side of scale). By means of a straight edge draw a straight line between the V and D values intersecting the S scale, also a straight line between the S and Z values (use S on right side of scale) intersecting the D scale. Connect these two intersections by a straight line and extend it to intersect the DVS/Z modulus scale (left side of Z scale). This intersection determines automatically the type of flow.

If the flow falls within the viscous range, consider solely the heating or cooling effect of the liquid, since the type of interior pipe surface has been shown to have a negligible effect. The amount of heating or cooling is evaluated by determining the difference between the temperature of the pipe and the average temperature of the fluid flowing through the pipe. The temperature drop scale covers a total range of 160 *centigrade* degrees which represents the data as published in the article[1] mentioned at the beginning of this paper. If no heating or cooling occurs, use the isothermal point. Through the proper point on the temperature drop scale, draw a straight line connecting the liquid viscosity value on the short horizontal viscosity scale, intersecting the short temperature drop-viscosity line midway between them.

Through this point, on the short vertical line, draw a straight line, connecting the point just determined on


ALIGNMENT CHART FOR DETERMINING THE PRESSURE DROP DUE TO THE FRICTIONAL RESISTANCE OF A FLOWING FLUID
LEGEND FOR TURBULENT FLOW
USE S CURVES FOR SMOOTH TUBING- DRAWN COPPER OR BRASS
USE R CURVES FOR ROUGH STEEL OR CAST IRON PIPING
V
ΔP
S
D
Z
TURBULENT FLOW CURVES
ISO-THERMAL
HEATING
COOLING
VISCOSITY
TEMPERATURE DROP VISCOSITY LINE
VISCOUS FLOW RANGE
INTERMEDIATE OR CRITICAL RANGE
TURBULENT FLOW RANGE
PRESSURE DROP- POUNDS FT⁻²
VELOCITY- FEET SEC⁻¹
FRICTION FACTOR -ALSO- PRODUCT V²S
SPECIFIC GRAVITY
USE WITH X
USE WITH Z
QUOTIENT- FRICTION FACTOR INSIDE DIAMETER
INSIDE DIAMETER OF PIPE- INCHES
MODULUS= DVS/Z
RELATIVE VISCOSITY- CENTIPOISES
BASIS = 1 FT. LENGTH OF PIPE
Δ DATA FROM "PRINCIPLES OF CHEMICAL ENGINEERING" WALKER LEWIS AND McADAMS - 1927 ED. PAGE 87
O DATA FROM "HEATING PIPING & AIR CONDITIONING" J.J. HARMAN - VOL. I NO. 4 PAGE 275
7-12-30 T.C.P.
I.
II.
III.
× = INITIAL KNOWN VALUE
⊙ = INTERSECTION
~ = VALUE DESIRED
I. - DETERMINATION OF DVS/Z
II. - DETERMINATION OF THE FRICTION FACTOR
III. - DETERMINATION OF THE PRESSURE DROP

the DVS/Z modulus scale, and extend to intersect the friction factor line.

If the flow falls within the turbulent range, again extend a straight line to the friction factor line, but in this case focus attention on the type of inside pipe surface, drawing the line from the DVS/Z value tangent to the turbulent flow curve which most closely represents the particular case in hand. The plotted curves represent two sets of data which are in close agreement for smooth tubing, but which vary somewhat for rough inside surfaces. The values given by Harman probably represent piping of greater interior surface roughness, due to corrosion, pitting of pipe, incrustation, etc. It is probably safe to assume that most conditions will be covered between the limits as plotted, but considerable caution should be exercised in judging what intermediate value applies.

If the flow is within the critical range, it is best to determine the friction factors corresponding to each side of the region (end points of viscous and turbulent flow regions) and then interpolate between these values as found on the friction factor line.

If the point as determined on the friction factor line is now connected with the inside diameter of the pipe value on the D scale intersecting the "FRICTION FACTOR/DIAMETER" line, and the values of V and S (use S on left side of scale) are connected by a straight line intersecting the friction factor or $V^2\,S$ line, then a straight line connecting these two new intersections will cut the pressure line when extended, at a point which gives the answer to the problem.

Since the basis of the chart is one foot of pipe length, it is necessary to multiply the answer as determined above, by the pipe length, to get the total pressure drop due to frictional resistance through the pipe line. Account must be taken also of the added resistance due to pipe elbows, bends, valves, and various fittings. This is done by expressing their resistance in terms of an equivalent length of pipe. Tables[4] are readily available which express this equivalent length of straight pipe in terms of pipe diameters.

To determine the hp. necessary to overcome this computed frictional resistance, multiply the total pressure drop (pounds/ft.^{2}) by the volume of discharge (ft.^{3}/sec.) and divide the product by 550.

The accuracy of the chart is within the limits of precision which the data warrant. Since the value of a result obtained by this chart is no more accurate than the least accurate value used in obtaining an answer, and since the accuracy of the estimation of the roughness of the pipe interior, or the determination of the temperature drop from pipe to fluid in the viscous flow range is rarely known closer than 5 per cent, it follows that any answer obtained should be credited with the same order of precision.

It should be noted that although the data for the temperature drop scale are based on oils having a wide range of temperature coefficients of viscosity, yet some cases will arise where the temperature drop scale will not closely apply, but in any case the result will be closer approximation than if the isothermal point is used, as has been the practice in the past.

[4] Heating, Piping and Air Conditioning, page 276, No. 4, Vol. 1.

Sample Problems:

1. It is required to transport 30,000 barrels of mineral oil per 24 hours through a 10 in. cast iron pipe line, the oil having a Baumé gravity of 27 degrees and a viscosity of 130 Saybolt seconds at an average temperature of 85 F. Calculate the head loss per 100 ft. of straight pipe due to frictional resistance.

Solution:

Determine the values of D, V, S and Z.

D = diameter = 10 inches.

V = velocity.

Rate of volume discharge =

$$\frac{30{,}000 \text{ bbls. oil} \times 42 \text{ gals./bbl.}}{24 \text{ hrs.} \times 3600 \text{ sec./hr.} \times 7.4 \text{ gals./ft.}^3} = 1.97 \text{ ft.}^3\text{/sec.}$$

$$\text{Velocity} = \frac{1.97}{.0055 \times (10 \text{ in.})^2} = 3.58 \text{ ft./sec.}$$

S = Specific gravity:

$$\text{Specific gravity} = \frac{141.5}{131.5 \times 27 \text{ (Baumé degrees)}} = .89$$

Z = Viscosity:

$$\text{Kinematic viscosity} = .0022 \times 130 \frac{1.80}{130} = .272$$

Relative viscosity = $.272 \times 100 \times .893$ (sp. gr.) = 24.3 centipoises.

Locate the modulus value, DVS/Z, on the chart. Since it falls in the turbulent range, draw a line from this value, tangent to the turbulent flow curve (cast iron pipe curve according to Harman), intersecting the friction factor line. Continue the solution by means of the chart to get the pressure drop value of .53 lb./ft.^{2}. To convert this to head loss per 100 ft. of pipe, multiply by 100 and divide by the density (62.4 = density of water).

$$\frac{.53 \text{ lb./ft.}^2 \times 100}{.893 \text{ (sp. gr.)} \times 62.4 \text{ lb./ft.}^3} = .94 \text{ ft. head loss per 100 ft. length of pipe. } \textit{Ans.}$$

2. Oil having a viscosity of 80 centipoises at 32 C and a specific gravity of 1.2 is being pumped through a one-inch (inside diameter) brass pipe line. The average temperature of the oil is 32 C. The temperature of the pipe averages 80 C. The oil is being discharged at the rate of 1.32 ft.^{3}/min. What is the pressure drop per foot length of pipe?

Solution:

Determine the value of D, V, S and Z.

D = Diameter = 1 inch.

V = Velocity:

$$1.32 \text{ ft.}^3\text{/min.} = \frac{1.32}{60} = .022 \text{ ft.}^3\text{/sec.}$$

$$\text{Area of pipe} = \frac{\pi d^2}{4} = \frac{3.1416 \times (1)^2}{4} = .7854 \text{ in.}^2$$

$$= \frac{.7854}{144} = .0055 \text{ ft.}^2$$

$$\therefore \quad V = \frac{.022}{.0055} = 4 \text{ ft./sec.}$$

S = Specific gravity = 1.2.
Z = Viscosity = 80 centipoises.

Locate the modulus value DVS/Z on the chart. Since this value falls in the viscous flow range, locate the temperature drop 48 C (80° — 32°) on the temperature drop scale (heating zone) and the viscosity value, 80, on the short horizontal viscosity scale. Connect these values by a straight line intersecting the short, vertical, temperature drop-viscosity line. Through this intersection, from the DVS/Z value previously determined on the viscous flow range, draw a straight line intersecting the friction factor line.

Using this point for the friction factor value and completing the solution, the answer is read directly on the pressure drop scale, 20 lb./ft.² *Ans.*

Note: If the flow had been isothermal (average pipe temperature 32 C) the pressure drop per foot of pipe length would have been a value of 31 lb./ft.²

Construction Lines Should Be Drawn Carefully

Mr. Patton is to be commended for preparing his alignment chart for determining the pressure drop due to the frictional resistance of a flowing fluid. Alignment charts are very useful and save a great deal of time when involved computations have to be made. They also reduce the chance of errors, such as the use of the wrong units, the transposition of figures, the misplacing of a decimal point, or simple arithmetical errors which sometimes creep in. The use of Mr. Patton's chart will be especially helpful when it is desired to find the proper size of pipe for a particular installation in which all other conditions are definitely fixed, because it shortens the work of making the several necessary trial computations for various pipe sizes which has to be done before arriving at the desired size.

However, in order to secure accurate results the chart must be accurately laid out to a sufficiently large scale, and in the solution of a problem the construction lines for locating the various points must be carefully and accurately drawn. A certain amount of familiarity with the proper method of applying the chart must be acquired also, and until this is accomplished the results should be checked by computation in order to make sure that the chart is being correctly used.

The experimental data on which Mr. Patton's alignment chart is based appear to be a very valuable contribution to existing knowledge of factors affecting the flow of viscous fluids in that definite values are established covering the effect of heating and cooling on the flow characteristics of certain types of oils. It had been known, of course, that variation in the temperature of the liquid at the center of the stream and at the wall of the pipe may cause a pressure drop differing from the calculated results based on the average temperature, particularly when the flow is stream line and when the viscosity of the liquid increases rapidly with a relatively small change in temperature; but the magnitude of this effect is rather startling when the pipe is heated or cooled to a temperature widely different from the average temperature of the oil.

It also appears reasonable to expect that oils such as certain California crudes which rise in viscosity more rapidly with a fall in temperature than the oils for which friction data of the new type is now available will be affected to an even greater extent by drastic heating and cooling.

Use of Isothermal Friction Data

However, there are a great many pipe line calculations where no intentional heating or cooling is employed, and in such cases the isothermal friction data formerly used is correct and may still be applied under the following conditions:

1. When the flow is turbulent.
2. When the flow is stream line and the temperature of the pipe wall is practically the same as the temperature of the oil.
3. When the flow is stream line and the temperature changes to which the pipe wall is subjected are sufficiently gradual to permit transfer of the heat without establishing a large difference between the temperature of the pipe wall and the average temperature of the oil.

In cases where the pipe line is heated or cooled very much in carrying out refining processes, or for the purpose of reducing friction losses, these friction data unquestionably offer a means of more accurately predetermining friction losses and should be of great value in designing pipe lines and equipment of this character.

However, the added complication of taking into account the difference between the average temperature of the pipe wall and the average temperature of the oil increases the difficulty of such calculations which were already rather confusing to the ordinary engineer who does not have occasion very frequently to compute the pressure drop of a viscous fluid and consequently is only vaguely familiar with the various viscosity units employed.

Charts such as Mr. Patton's which reduce the solution of such problems to a simple mechanical operation should be very useful.—*J. J. Harman.*

Judgment Needed in Estimating Roughness

In regard to the article by Mr. Patton, I might say that such a monograph represents a very great amount of work in mathematical construction. I have long entertained the thought of such a chart but have always considered that the representation of all the variables would give a chart so complex that the average engineer would not take time to use it.

I picked the following conditions and ran them through on Mr. Patton's chart: Vel.—8 ft. per sec.; diam. of pipe—2.06 in.; water flowing (sp. gr., 1.00; relative viscosity, 1.00).

Depending on the choice between the two degrees of roughness given in the two curves labeled R the pressure drop arrived at varied from 6.6 lb./sq. ft. to 9 lb./sq. ft.—a considerable variation. If the pipe is considered as smooth, the pressure drop has a value of approximately 4 lb./sq. ft.—again a considerable variation. It would seem, therefore, that the estimation of the internal roughness involves the exercise of judgment to a large degree—*R. E. Gould.*

Five Systems Ventilate Apartment-Museum

WITH the completion last fall of the Master Apartment Hotel at 310 Riverside Drive, New York, acquired the distinction of having the first skyscraper museum ever erected and the first building to combine a museum with living quarters for several hundred human beings. This new building is an outcome of the growth of the Roerich museum and its affiliated institutions which were founded in 1922 and 1923. The Roerich museum originally occupied a small dwelling at 310 Riverside Drive, the same site on which the new building now stands. The museum was founded to house a collection of paintings by Nicholas Roerich.

Five Separate Ventilation Systems

This combining of a musem, auditoriums and art school with living quarters presented numerous novel problems to the architects and engineers and it is interesting to see how they were solved.

The ventilation is probably the most interesting of the mechanical features. There were five separate problems to be dealt with here, and five separate systems of ventilation had to be installed. The bathrooms, toilets, and serving pantries were provided with a separate exhaust system. The dining room and museum were each provided with a separate supply and recirculating system of ventilation. A number of smaller rooms which required ventilation were provided with concealed ventilating units. In addition, the auditorium was supplied with a system of ventilation which sent a downward supply of air from the ceiling and exhausted under the seats through mushrooms, thereby improving the acoustics of the hall by having the air flow from the ceiling toward the audience.

All the exhaust ventilators are brought up vertically to a space in the ceiling of the fifteenth floor, and from the sixteenth to the nineteenth floor there is a separate ventilator exhaust system. All the exhaust fans have been placed in the fan room over the pent house.

The auditoriums, dining rooms and museum are controlled with automatic temperature control systems.

The building is heated by a two-pipe vacuum system, the three boilers having a rated capacity of 22,000 sq. ft.

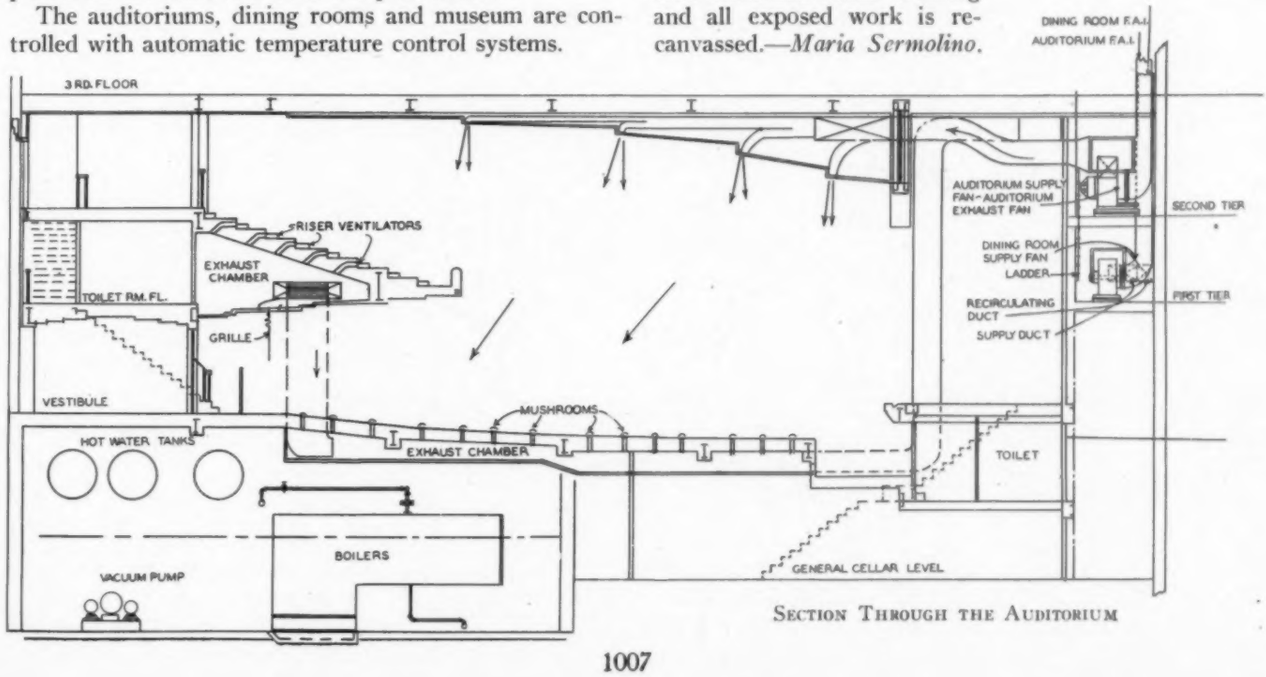
Cold and Hot Water Piping

The cold water supply in the building is equipped with two 4-in. brass mains connected to three two-stage horizontal centrifugal pumps, having a capacity of 450 gallons per minute. These pumps supply the water to the roof tank which has a storage capacity of 20,000 gallons. The supply from the house tank is distributed to each stack and thence to each fixture. Pressure reducing valves are installed on all branches below the thirteenth floor in order to regulate the pressure due to the exceptional height of the building. Pipe material for this system is galvanized wrought iron pipe with heavy galvanized malleable fittings.

All of the hot water piping system is of brass with heavy brass fittings and all branches below the thirteenth floor level are regulated by means of pressure reducing valves. The hot water supply is furnished by means of three heaters with a total capacity of 4,500 gallons per hour. The scheme of distribution is by means of drop risers to each line of bathroom and serving pantries and is individually supplied.

Fire Protection System

The fire protection system consists of two standpipe risers extending to the top of the building. There are two hose racks on each floor. This system is cross-connected at the cellar ceiling and extended to two siamese connections at the street level for the use of the city fire department. The hose-racks in the museum, school and auditorum section, as well as the dining room, director's rooms, etc., are enclosed in cabinets having glass doors. The system is regulated by a series of pressure reducing valves and the piping is of black wrought iron pipe with extra heavy fittings. It is covered with anti-sweat covering and all exposed work is recanvassed.—*Maria Sermolino.*



SECTION THROUGH THE AUDITORIUM

Decreased Death Rate of Poultry Represents Large Profit —Proper Air Conditions an Aid

By John H. Ruckman*

WHEREVER air-breathing animals are housed, provision must be made for ventilation. Nowhere is it more important than in those plants where farm bred poultry flocks are concentrated for fattening and slaughter. As in all industries, the buildings and systems of ventilation to be used must be designed with a view to attaining the maximum return from invested capital. In plants of this type, poultry is given a final fattening or "finish" before slaughter. During the winter months a comparatively small number is handled but from July to October, the feeding rooms generally are full, and the investment in buildings and equipment necessary is determined by this late summer peak.

The financial problems involved in operating these plants are somewhat similar to those characteristic of wheat flour milling, but there is one important difference. There is no method for selling live poultry short, hence the poultry feeder cannot hedge. This situation tends to emphasize the speculative features of the business, and the importance of controlling operating costs is likely to be overlooked, particularly during a period of advancing prices. When a period of declining prices sets in, however, a slight difference in cost of operation may cause the difference between profit and loss on every carload shipped, and in the long run it is the plants with low operating costs which survive periods of depression, and gain the greatest advantage from periods of prosperity.

* Consulting industrial engineer, Topeka, Kan.

Disease and Death, if Eliminated, Would Represent a Handsome Profit

As a guide to approximate amounts involved, it may be stated that a typical plant may have invested $100,000 in real estate, buildings, and equipment; it will carry a maximum of $50,000 worth of poultry in process, and a very small quantity of bills collectable, or payable. Such a plant will have a payroll of $40,000 a year; it may have total sales of $500,000 a year, and will suffer an annual loss from disease and death of poultry of from $7,500 to $12,500.

It will be noted that this last mentioned item is very important, being quite frequently larger than the total of all fixed charges, and would represent, if eliminated, a very handsome operating profit.

These deaths in process occur from various causes but the vast majority are due to infections of the nose, throat, eyes and tissues of the head, collectively termed "roup," although there are probably a number of different bacteria involved. These infections produce several distinct groups of symptoms, but all are characterized by pussy exudations from the nose, eyes and throat, and it is nearly certain that dry particles of this pus floating in the air can and do transmit the maladies.

Epidemics generally begin late in August or in September and continue till the next spring, running a course very similar to that of "cold in the head," and sinus infections among children in the public schools except that the mortality rate is very

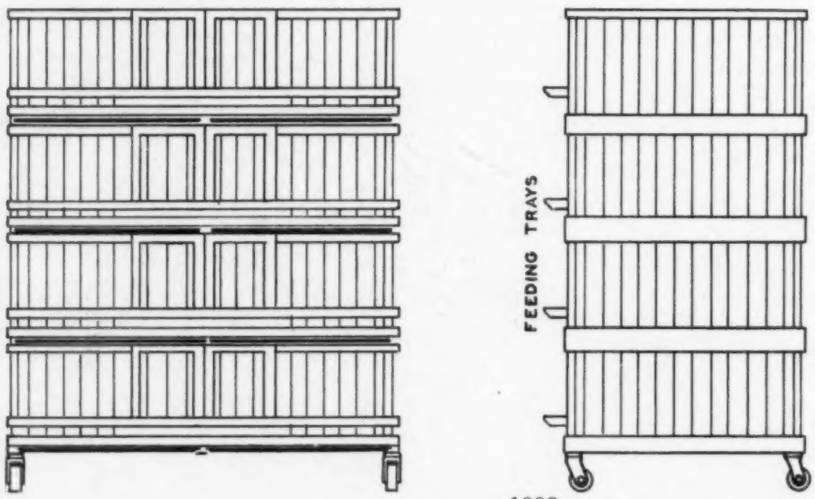


FIG. 1—A COMMON FEEDING BATTERY. THE TYPE OF BATTERY DETERMINES, TO A LARGE EXTENT, THE AMOUNT AND KIND OF VENTILATION

high. The reason for the appearance of these diseases at this season is not fully understood, but it is noted that epidemics of chicken typhoid and cholera on the farms occur at about the same time and it seems probable that the first chilly nights in some way lower the resistance of a certain percentage of fowls. This may be an effect of changed temperature, humidity, or both.

One of the principal difficulties in raising poultry for the market is the rather high death rate caused by air-borne diseases. Air conditioning may be used effectively to reduce this loss; this article, prepared by a consulting engineer who has made a careful study of the problem, indicates to the air conditioning engineer what he can do in the poultry industry.

There has been a gradual decline in practically all poultry and poultry products since 1922, a severe and sudden drop last fall, and prices have continued to sag while the amount of the product in storage shows no sign of decreasing. Poultry packers agree they have never had as much trouble in obtaining the necessary margin as at present. The farmers, following the market reports closely by radio, are inclined to drive hard bargains; and, because of the general agricultural situation, they are not feeding the poultry as well as might be desirable, putting the burden of bringing the poultry up to grade for the market on the packers. The packers, too, find competition keen, as many of their competitors are running their plants at a loss to keep them busy.

The plants with the low operating costs will survive; air conditioning should be considered as a means of reducing operating losses through deaths by disease.

Ventilation Important in the Feeding Battery

The operation of the poultry feeding house is as follows. Poultry is brought in by farmers or by special buyers in small portable shipping coops. The poultry is examined by an expert who classifies them, as "broilers," "fries," or otherwise and also examines them so far as possible for evidence of contagious disease. Once a sale has been agreed upon, each class of chicken is placed in a special scale cage, and after weighing is transferred to a feeding battery. This battery is the most important unit of the plant and it largely determines the amount and type of ventilation which is practicable. There are at present two types in general use, one built on a wooden frame, and a newer type, entirely of steel. In both there are four tiers, each of two coops. The coops are generally 30 in. deep, 24 in. wide, and 13 in. clear height. The entire battery is mounted on wheels and is 60 in. in height. A removable refuse pan separates each coop from that below it, and while this feature is absolutely necessary for cleanliness, it interferes with any vertical movement of air.

So far as the writer knows no studies have ever been made to determine whether this type of battery is the most efficient. It is, however, of a height and weight convenient for the operatives and is in such general use that alterations should not be considered unless there is some definitely demonstrable advantage to be gained. The number of chickens loaded per battery and per coop varies but for "spring chickens" (3 pounders) 8 per coop or 64 per battery is common. The battery thus occupies 50 cu. ft. and carries about 200 lb. of air-breathing flesh.

After leaving the receiving room, the batteries are wheeled to the feeding room where they are placed in double rows end to end and back to back, leaving the feeding trays accessible along aisles approximately 3 ft. wide, through which operatives distribute feed or wheel batteries to and fro. The feeding period varies; with good raw material, the batteries full, heavy receipts and a falling market, it may be only four days; under reverse conditions it may be extended to 14 days.

At the close of the feeding period the batteries are wheeled to the killing room where the product is killed and inspected. From this point it is forwarded to the cooling room, where it is graded and packed, after which it is ready for refrigeration and shipment.

Relation of Heating and Ventilating to Economy

The problem of heating and ventilating is two-fold. During July and August, the poultry must be protected from undue heat. During October nights, and from then on into the winter, protection must be provided against cold. In feeding rooms with a fair supply of openings, deaths during the summer months of overcrowding and heat exhaustion are rare in the Middle West, but in very hot weather the poultry loses appetite and fails to acquire the necessary "finish." Hence, most feeding rooms are designed with a free circulation of summer breezes across the batteries as the controlling factor. Large windows and high ceilings are the rule, and in many cases inadequate provision is made for fall and winter conditions.

About October 1, when the nights begin to be chilly, the batteries are full and a floor space of 10,000 sq. ft. will contain 115,000 lb. more or less, of poultry. The body temperature of the birds is higher than that of mammals, respiration is twice as rapid, and according to Calin, each 1,000 lb. of poultry will breath 8,278 cu. ft. of air each 24 hours, or about three times as much air as adult human beings of the same weight would consume. Whether the amount of water and carbon dioxide exhaled is proportionate is not definitely known, but it is probable that it is, or is nearly so. The fact that chickens are of much smaller size than human beings is also an important factor, since they possess from three to four times as much radiation surface per pound as a human being. This fact brings up a very important point in heating and ventilating economy. Should the feeding houses be heated?

The domestic fowl is believed to have been derived from the tropical "jungle cock," and as stated above deaths from excessive heat are very rare. On the other hand, low temperature, particularly with dampness, invariably results in lowered vitality. It has been found that at temperatures below 60 deg., the consumption of food is increased per pound of weight gained, and at temperatures above 65 deg., the poultry while healthy, loses appetite and fails to gain. A room full of poultry such as has just been described, will probably generate 1,000,000 Btu per hour, which is sufficient to maintain a suitable temperature for most feeding rooms, when the thermometer is at freezing. It is clear, however, that the birds cannot be exposed to incoming air at or

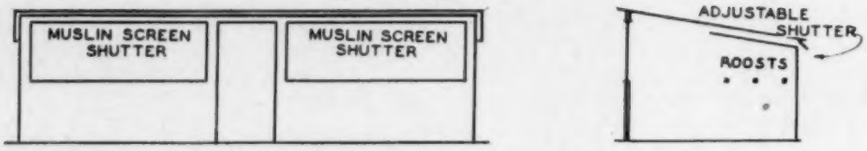


FIG. 2—HEN HOUSE APPROVED BY KANSAS STATE BOARD OF AGRICULTURE

near freezing. Such air must be artificially heated, warmed by heat exchangers or mixed with air that is warmed before it is brought into contact with the batteries. This is especially true in December and January when temperatures are lower and when the number of chickens has been reduced.

No experimental data are available as to the effect on poultry in confinement of humidity, carbon dioxide, and exhaled air. Since all domestic fowl were originally wild birds and accustomed to open life, and since chickens and turkeys seem to thrive in temperate summer conditions, it is probable that the humidity should be held between 50 and 75 per cent. Carbon dioxide, as we know, is chiefly an indicator of amount of use of the air, and while we know nothing of the effect of recirculation among healthy chickens, it is nearly certain that where roup is present, recirculation, particularly at high velocity, offers a means for spreading that disease.

Practically all publications relative to poultry raising stress the danger of drafts. It is the writer's very firm opinion that air currents at healthful temperature and humidity are not injurious except as they may serve to carry disease germs. On the other hand, an air current passing across a cold surface where its temperature is reduced and its relative humidity correspondingly raised, or hot dry blasts, as with human beings, may be much more dangerous to health than recirculated air, properly conditioned.

Existing Types of Plant

The vast majority of poultry feeding plants endeavor to solve the question of ventilation wholly by air leakage and body heat of the poultry. It has been found that poultry houses of the design shown in Fig. 2 provide the fowls with good protection on the farm and the majority of battery rooms are simply adaptations of this design. A typical layout of this design is shown in Fig. 3.

There is great difference in practice relative to the area of window openings on the northern and western sides. Such openings are highly desirable in summer but in winter the exposure to direct radiation and to currents of very cold air of the batteries nearest the openings, is very disadvantageous.

Under the impression that long narrow houses are more easily ventilated than buildings which are more nearly equilateral, some operatives are now specifying the former. There is a tedency to overlook the fact that per square foot of floor area, and hence for a given capacity in batteries, this type of building may cost from 25 to 50 per cent more than one which is approximately square. The same money in the latter type of building will either provide additional capacity or, more important, will permit less crowding of poultry in process. Furthermore, leakage of air, and radiation from the long sides, greatly complicate the matter of heating and air supply during the season when the death rate is heaviest.

Buildings of more than one story are rarely utilized except at important railroad junctions where the cost of sites on trackage is high. The increased cost of the buildings is commonly given as the reason, but in addition, careful observation has convinced many operators that poultry placed on the ground floor is more healthy than poultry placed on the upper floors. This view is sound in buildings where there are openings between floors. In all multiple-storied buildings, each floor should constitute a complete unit.

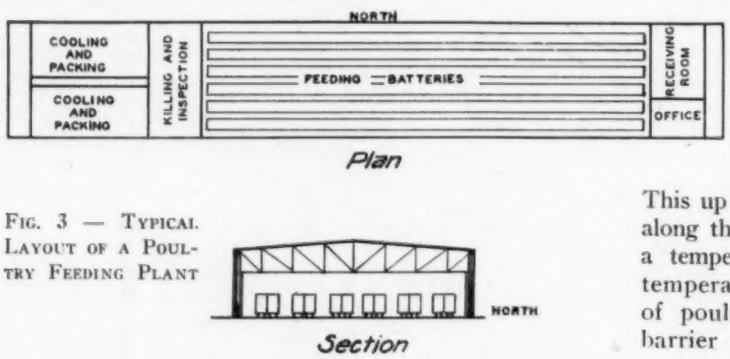


FIG. 3 — TYPICAL LAYOUT OF A POULTRY FEEDING PLANT

Air Circulation in Typical Plant

During the winter of 1927-28 the writer had opportunity to make a study of a typical multiple-storied poultry feeding station with a view to determining the actual circulation of air, and to gain approximate data relative to humidity and purity. The work was carried on in December when the house was filled to only about 33 per cent capacity. An epidemic of roup, which had killed some $7,000 worth of birds that season, was still in progress.

The circulation within the buildings differed but little with external wind conditions. When it was very cold outside, and when the northwest wind was blowing, the downward currents on the north and west walls would increase in speed, and the drafts from the door at the receiving platform on the ground floor increased in intensity. The general circulation as outlined in Figs. 4, 5, 6, and 7 remained, however, nearly the same. The trend across the southern windows was unstable, being up at times and down at others.

The most noteworthy feature was the steady current of warm air rising from the batteries. This up current attained a velocity of 4 feet per second along the fronts of the cages and just above them had a temperature as much as 20 deg. higher than the temperature on the floor. The batteries, when full of poultry seemed to offer an almost impassable barrier to definite horizontal air currents, and no

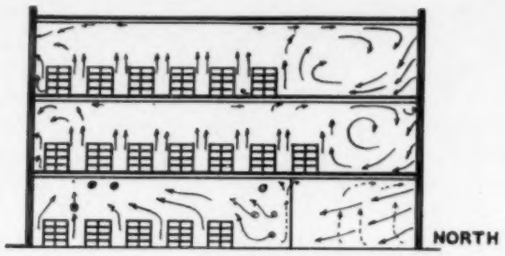


FIG. 4—CIRCULATION OF AIR AS DETERMINED FROM TESTS OF A MULTIPLE-STORIED POULTRY FEEDING STATION

matter how strong a current impinged on the first row, it was converted into a rising current before reaching the second aisle. At the second aisle there was seldom appreciable cross movement even along the floor.

The air behind the bars of the batteries was practically stagnant. It was noted that the humidity was generally moderate (about 60 per cent). That it was not higher along the north wall was due to a steady infiltration of relatively dry air from without. Traces of carbon dioxide could be identified above the batteries except on the ground floor.

The second feature of interest was the powerful up-draft through all openings in the building. On the stairway and at the elevator opening between the first and second floors, a velocity of 16 feet per

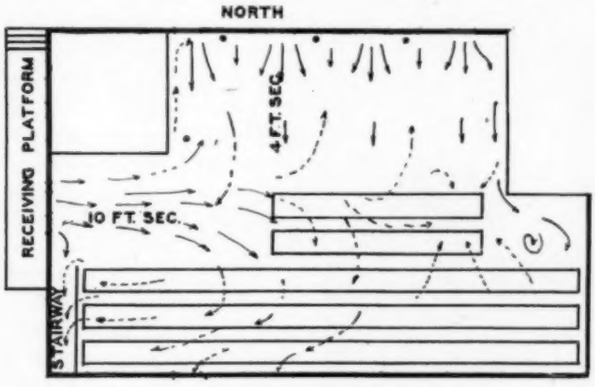


FIG. 5—CIRCULATION ON GROUND FLOOR

second was noted. Despite leakage from north windows, the temperature rose from floor to floor averaging 47 degrees on the ground floor, 55 degrees on the second and 65 degrees on the third, at the upper deck in the batteries. Air in the third story was found to be noticeably vitiated, carbon dioxide occurring in concentrations of 0.5 per cent in slow eddies near the floor in the southeast corner.

It was noted that despite the fact that they were directly exposed to blasts of cold air whenever the door was opened to the receiving platform, fowls on the lower floor were relatively healthy and despite low temperature, fattened well. Those on the second and third floors were not of equally uniform quality and were dying rather frequently. It was noted among these that the development of roup among fowls in the upper tier of a battery did not entail the spread of the disease to those below. It appeared on the other hand that infection in the lower tier generally spread upward, but the number of observations was insufficient to make certain of this point. There seemed little or no tendency for the disease to pass from one battery to the next.

An effort was made to locate and measure air currents beneath the floors of the lowest tier of cages in the batteries, but the results were irregular. The currents seemed faint, variable and intermittent. There seems little doubt, however, that the feet of fowls on the lower tier were relatively cold. It was also noted that the fowls in the middle decks tended

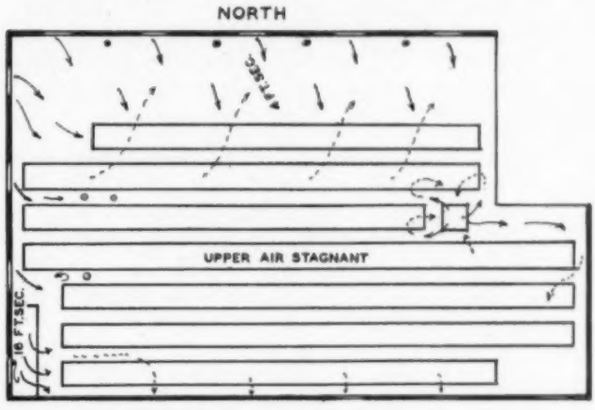


FIG. 6—CIRCULATION ON SECOND FLOOR

to keep the head and neck outside the batteries. In general it may be said that while the observations were made under considerable difficulties and were not taken with a high degree of precision, they agree fairly well with theoretical considerations and at least furnish a guide for design and further investigation.

Some Conclusions

In view of the various points which have been brought out it is believed that certain conclusions can be drawn. Long, narrow buildings are not necessary, and a logical arrangement can be developed for almost any plot of ground. The total natural body beat of the poultry is sufficient to supply the total necessary heat in most instances, but windows and other points at which cold air may leak, or where direct radiation from the hot bodies of the poultry may occur, should be shielded in winter by

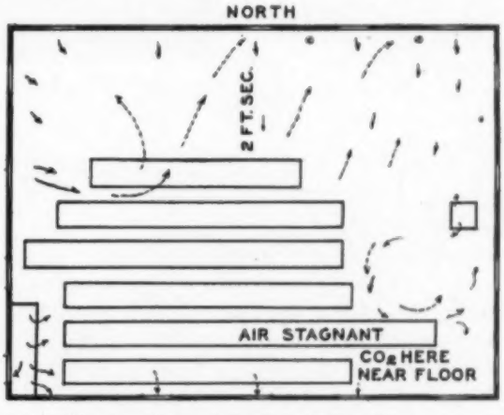


FIG. 7—CIRCULATION ON THIRD FLOOR

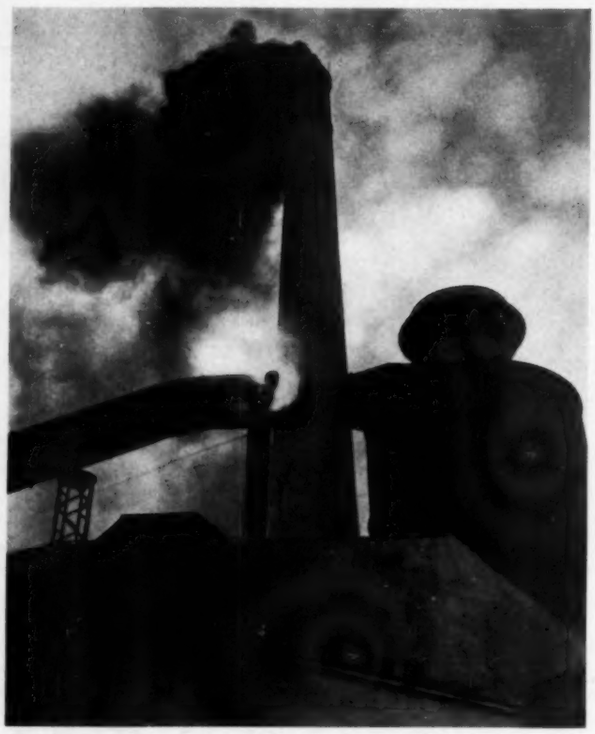
temporary brattices or curtains; using food as a source of heat is highly uneconomical. The recirculation of air which may be polluted by roup virus is highly undesirable, and positive means should be provided to cause air to pass through the batteries once only, and except when all windows are open as in summer, currents along the battery faces should be held to a minimum. In the absence of tests proving the contrary, air entering the room should be brought to 60 deg. F and a humidity of 50 per cent. The heavy up-current along the batteries will interfere with any descending circulation system; blowers set high above the batteries and producing turbulence similar to summer winds may prove effective, provided the blast is properly conditioned, and recirculation kept at a minimum. Ascending circulation should prove ideal, but to obtain its full benefits, batteries should not be spotted quite as closely as is now customary. All-metal batteries permitting freer circulation of air are an improvement over older types.

To date, so far as the writer is aware, no plant, at least in the Southwest, has been built with a positive system, using conditioned air. As has been shown, the expense may be justified if by ventilation, even a fraction of the loss caused by roup can be eliminated. To date, positive proof that modern air conditioning will reduce losses to an extent which will justify the additional investment is still lacking, but it is the writer's very firm opinion that a great improvement can be made, and that it is but a question of a short time until the advantages of carefully planned air conditioning systems in poultry feeding rooms will be commercially demonstrated.

Sweeping Cobwebs Out of the Sky

By Malcolm Tomlinson*

EVERYONE remembers the story of the old woman who wanted to sweep the cobwebs out of the sky. It was only a nursery rhyme, but, like other rhymes of the same sort, it had a lot more sense to it than we suspected. At any rate, from the all too brief account which has come down to us, we have reason to believe that the old lady must have been an excellent housekeeper who abhorred dirt and dust. Through many years she had observed that, no matter how often her house was cleaned, it soon became dusty again. No doubt she had noticed, when the sun was shining, the dust that floated in the air. In winter, with snow on the ground, she had additional evidence of the dustiness of the atmosphere. The crust or top surface of the snow soon became dirty. Even the falling rain and snow brought down dirt, through the atmosphere from the "sky." All of this evidence pointed to a sky origin of dirt and dust. The years passed on and our old lady, like many other human beings, gradually reached the place where her patience was rather short. There came a day when she felt that she could stand dirt and dust no longer. If Mother Nature could not do a better job of keeping the atmosphere clean it was about time that someone else took the matter in hand. With the assurance of one who has always been successful in past ventures, she never doubted but that she was the very one to undertake the work. She failed.



THERE ARE 5,000 TO 20,000 PARTICLES OF DUST PER CUBIC FOOT OF AIR IN LARGE CITIES

Actually this old lady deserved a lot of credit. She not only saw part of the dust problem quite clearly, but she started out boldly, with the only equipment then available, to solve the problem. The method was terribly crude from the standpoint of the present. The idea was correct even though the result was failure.

Air Cleaned to Protect Quality of Products

Many years passed by. The development of fans and blowers led to the use of paper, cloth and metal screens for cleaning and filtering air in special industries where dust seemed to be a real problem. Right here it is well to remember that the first efforts at cleaning the air were to protect and to raise the quality of the products of industry. Only a few venturesome souls dared to suggest that the health and comfort of the employes should also be protected in like fashion. For the products of industry, in those days, were more important than the worker. In fact, this axiom of the old, or past, industrial cycle still sways the policy of more plants than we imagine. The coming of the dynamo and the rapid rise of the electrical industry gave a new impetus to the fan and blower

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Salt Particles From the Evaporation of Sea Spray Are Harmful to Papers and Textiles

business and a more practical touch to air cleaning. Air washers were invented in response to the demand for effective elimination of dust and dirt. In more recent times, due to the great increase in soot and unconsumed carbon fumes and dust, other types of air cleaners, for this particular purpose, were needed. The viscous type of air filter, which is specially designed to catch dusts which are light, greasy and insoluble in water, was developed, as were fabric filters.

Classes of Dust

Few of us have a clear understanding of what is meant when we are told that there are from 5,000 to 20,000 dust particles per cubic foot of air in large cities. The *American Society of Heating and Ventilating Engineers* has divided the various forms of atmospheric pollution into dusts, fumes and smokes. Each form is defined on the basis of weight and average size. Here, too, we find it impossible to visualize these classes because we are not accustomed to thinking in terms of such small units. What we need is a clearer picture of the dust problem. To get such a picture it is necessary to go back to the beginning. What is atmospheric dust? How does it originate? What is the effect of such dust on human beings? What is the effect on industry and weather? When we have some knowledge of the answer to these and similar questions regarding the "cobwebs in the sky," or atmospheric dust, we will not only know why air must be cleaned and filtered, but also what is the value of particular types of cleaning equipment now on the market.

Climatologists tell us that atmospheric dusts fall into eight classifications. They are mineral, vegetable fibers, pollen, spores and bacteria, soot and unburned carbon, salt particles, volcanic dust or ash and meteoric or cosmic dust. The first five types of dusts reach the air from the earth, by means of winds or air movement. The second and fifth types of dust particles usually find their way into the air by means of convected heat from such sources as ranges, furnaces, boilers, forest fires, automobiles. The last three types of dusts are seldom considered when air cleaning problems arise, although they represent, at times, a large portion of the dust in the air.

Salt Particles Harm Textiles and Paper

Mineral dusts are fine particles of rock. Vegetable fibers consist of decayed leaves and other similar rubbish. Plant and tree pollens find their way into the air in the spring, while grass and weed pollens are picked up by the winds in the summer and fall. These pollens often cause hay fever and are thus a cause of trouble to man. To the farmer they provide a mixed blessing and curse in that they aid cross fertilization and also are responsible for the spread of weeds.

Salt particles are formed by the evaporation of sea spray. They are found not only in the air over the ocean, but often far inland. In the latter case gales and hurricanes furnish the means of transportation. Salt particles are particularly harmful, in the presence of moisture, to textiles and paper due to the acid which is thus formed. Volcanic smoke or ash, when ejected to great heights above the earth, takes a long time to return to the earth. There are instances in which explosions which have occured in modern times have thrown out dust which has not reached the earth again inside of two to three years. Meteoric dust is the ash from millions of meteors which burn in the atmosphere of the earth every day.

Dust Affects Weather

These various dusts form nuclei which collect water vapor from the air. If we return to figures as a means of description, for comparative purposes, of these nuclei it can be said that they average 40,000 per cubic inch of air under average outdoor conditions. Dr. W. J. Humphreys has estimated that it would take a month to count all of the dust particles which a human being inhales in a single breath. It is thus evident that most of these dust particles are much too small to be considered in many of the filtering processes used for air cleaning. Nevertheless they play a very important part in weather. It is through their aid that the moisture which forms the rain is collected into droplets. They form a goodly portion of every fog and they are also responsible for the clouds which we see in the sky. In the special case of volcanic dust drifting around the earth, meteorologists are now in agreement that such screens adversely affect the amount of heat which the earth receives from the sun. Investigations of every volcanic eruption since the year 1750 have shown that particularly cold years have always followed these explosions when the ash has been thrown so high that it has taken a considerable length of time to return to the earth. These dust screens usually make a difference of from 1 to 2 degrees in the mean air temperature. This seems to be a very insignificant matter. Yet it means the same thing as a change of latitude of from 80 to

150 miles. While such facts are extremely interesting, they are only side lights and give no particular information on air cleaning.

Fumes a Problem

So far the only cobwebs which we have seen in the sky have been dust particles. Furthermore, it would appear that they certainly are plentiful enough to furnish a real opportunity for anyone who has the courage to tackle such an air cleaning job. When the old lady undertook her famous adventure only the very wealthy used clothing made of silks and other delicate fabrics. No matter what the product, the pride of the weaver, the shoemaker, the printer and all of the other tradesmen was to turn out strong and sturdy articles which would wear not only well but also a long time. It was the day of the "deacon's one horse shay which lasted a hundred years to the day." For these reasons the old lady never dreamed of another form of cobweb which, in modern times, presents a problem of considerable proportions. The product of our own factories is not so sturdy. As a whole, increased demand, added to the universal desire for a lower first cost and because of the influence of styles, has resulted in goods which must be scrapped in a comparatively short time. So our fabrics are not only frail, but also delicate; our papers will not, as a whole, serve for the printing of books which will be legible for another century. The same story applies to practically all of the goods which we make.

This "cobweb" which increases our need for air cleaning is a form of fume. It consists, among other things, of gases such as ammonia and the oxides of nitrogen and sulphur. The nitrogen oxide is caused by electrical discharges and, when united with moisture, forms nitric acid. The sulphur oxide is one of the products of combustion of coal, oil and gas. It forms sulphuric acid when mixed with moisture. To these gases must be added, especially in the regions where the population is dense and industry abounds, many other gases which form acids in the same manner. Sulphuric acid is one of the most dangerous acids formed from air fumes and also one of the most prevalent, as it is constantly precipitated out of the atmosphere of large cities and industrial centers. All of these acids aid ordinary wear and tear in the destruction of materials and products which we use.

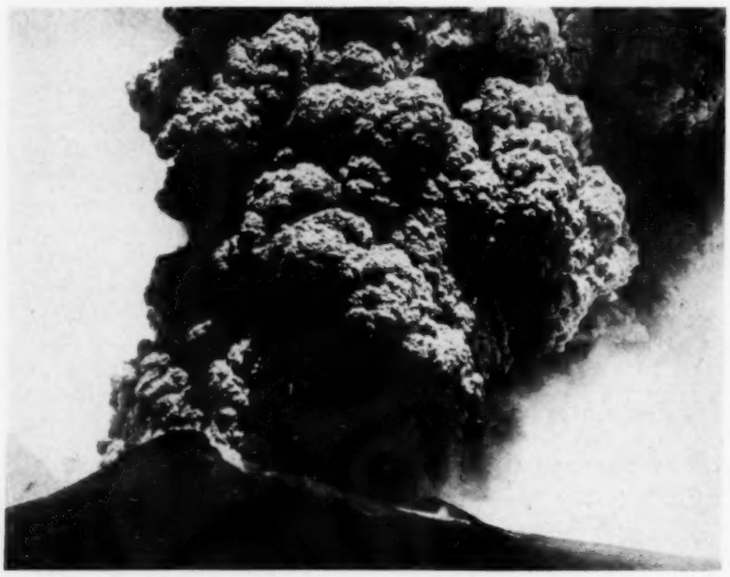
We have seen something of the effect of dust, dirt and fumes on weather and industry. Let us see what they mean to man in a physical sense.

The cold years which follow great volcanic explosions entail great losses to farmers in agricultural products. The reaction is often as severe, from a financial standpoint, as that which follows long droughts. Volcanic dusts, together with some other forms of dusts which have been mentioned, have sharp edges, which are not only destructive to fabrics but are also highly irritating to the human throat, nose and lungs. Pollen, of course, causes hay fever. Salt particles, driven by the wind, are irritating to the skin, but, when dissolved by moisture, have a healing effect on the mucous membrane. Soot increases laundry bills and, because of its insolubility in water, is especially harmful in the lungs of those who breathe it. No one, of course, will have any doubt as to the results which can be expected from breathing decayed vegetable matter, bacteria or fumes.

When the average amount of dust particles in the air is from 3,000 to 14,000 times as much as the average amount which cleaning and filtering devices can be expected to remove from the air we have a fairly clear picture of just how dusty the atmosphere actually is. We can appreciate this all the more when we see the amount of dust and dirt which is removed from filters of air washers every day in buildings located outside of the industrial areas of towns and cities.

It is interesting to speculate on the difference in the earth's temperature and climate which would exist if the atmosphere were free from dust. Certainly it would be much hotter and it is possible that there would be less rainfall. From this standpoint the dustiness of the atmosphere is a protection to the human race. Nature, then, is not so negligent of the comfort of man as our old lady imagined.

On the other hand, we are always face to face with the dust removal problem. There is only one way out and that is through the medium of cleaning and filtering devices. The development of these devices has reached a stage where efficient air cleaners can be had by anyone. The day is close at hand when the public will realize this fact and will demand air conditioning systems and the advantages of air cleaners for *all* buildings and homes. They will be adaptable to cooling in the summer and will also keep the indoor air clean throughout the year. The relative humidity will be controlled in both summer and winter.



Cold Years Usually Follow Volcanic Eruptions

Inside Air Conditions Balanced With Outdoor Temperature

By Will H. Mayes

FIG. 1—THE FIFTEEN STORY NORWOOD OFFICE BUILDING WITH THE MOTOR RAMP GARAGE IN THE FOREGROUND. THE AUSTIN CLUB IS ON THE GARAGE ROOF. GIESECKE & HARRIS, ARCHITECTS; LLOYD D. ROYER WAS THE CONSULTING ENGINEER

THE Norwood office building, built last year in Austin, Texas, was the second air conditioned building erected in this country for exclusive use as an office building, the Milam building at San Antonio, Texas, being the first of the kind.

The Norwood building is a fifteen-story and basement structure, built of steel, limestone and marble. Adjoining it is a motor ramp garage of the same general architectural design, on the roof of which is a club house connected with the office building by a passageway from the fifth floor.

From an engineering standpoint the problem was to distribute air, properly conditioned and cleaned, through each room and corridor of the office building and the adjoining club house, the air to be at an even temperature and yet always within a reasonable degree of the outside atmosphere, so as to avoid any sudden chilling of the people going into the building from the hot streets or any over-heating of those leaving the cooled building. At the same time it was essential to the comfort of those using the office building and club house, whether as tenants or patrons of the occupants or members of the club, that the right percentage of relative humidity be constantly maintained.

These conditions were especially necessary because a large part of the office building had been leased to physicians, and their patients would likely be unusually susceptible to radical changes in temperature or humidity and yet they would appreciate a properly adjusted and regulated air conditioning and cooling system and would profit in health thereby.

Conditions Necessary in an Office Building

In the construction of the air conditioning system, therefore, it was necessary to consider many special conditions, due to the nature of the occupancy and the service to be rendered by the various tenants, but the health and comfort of the occupants and the many people who would have occasion to visit the building was the first considera-

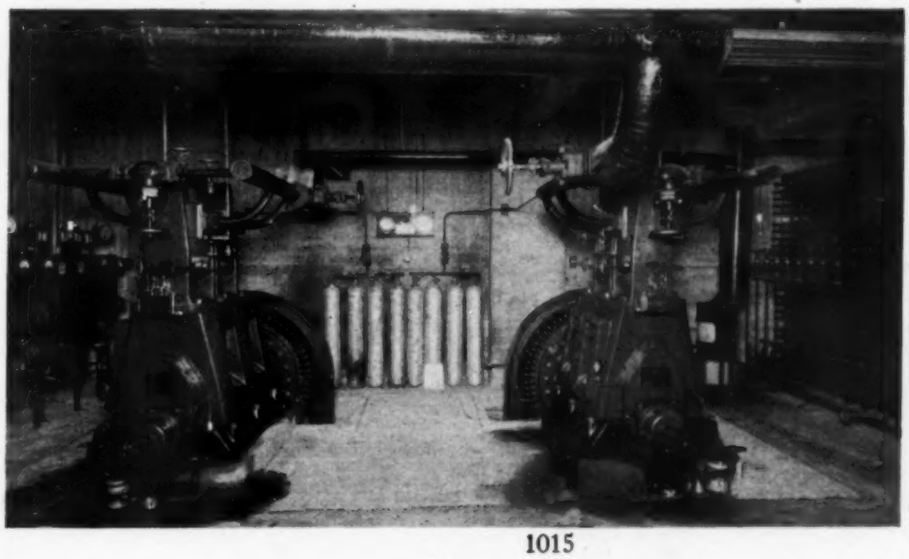


FIG. 2—TWO 125-TON CARBON DIOXIDE COMPRESSORS, DIRECT CONNECTED TO 200 HP. SYNCHRONOUS MOTORS, 2,300 VOLTS, 3 PHASE, 60 CYCLES. IN THE LEFT BACKGROUND ARE THE CONTROL PANELS, IN THE CENTER THE CHARGING STAND FOR CO_2 AND AT THE RIGHT MAY BE SEEN THE END OF THE CONDENSERS.

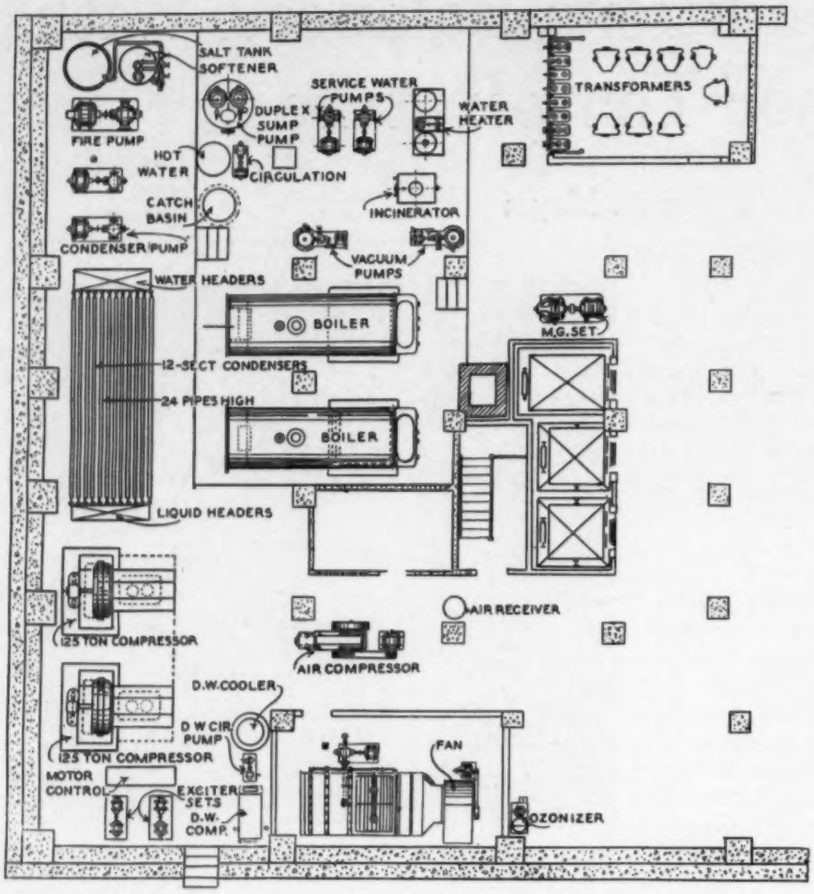


FIG. 3—A PARTIAL PLAN OF THE BASEMENT.

tion. It was recognized that four principal conditions are necessary for the physical health and bodily comfort of the tenants and patrons of a modern office building. Briefly stated these are:

(a) A sufficient quantity of fresh air must be supplied to every room, and throughout the corridors.

(b) There must be proper dry bulb temperature at all times. (The dry bulb temperature in an artifically cooled office space should not be more than 15 F lower than the outside existing dry bulb temperature, it was decided.)

(c) There must be proper wet bulb temperature. (After the dry bulb temperature has been established, the wet bulb temperature must be determined in order to obtain the proper relative humidity. Tests determined that the proper relative humidity with the air ranging from 70 F to 90 F dry bulb temperature is approximately 55 per cent.)

(d) The proper velocity of air must be supplied to the various rooms. (This is of great importance because too great a velocity may create objectionable drafts and noises; therefore, it is necessary to introduce the air at the correct velocity through properly distributed and correctly adjusted openings.)

With all these conditions in consideration, along with the fact that a large amount of the office space, though by no means all of it, would be occupied by members of the medical profession, special arrangements were essential to avoid the spreading of objectionable odors from one suite of rooms to another or into the corridors.

The elimination of all organic odors, as well as the freshening of the air, is accomplished by means of an ozone apparatus located in the basement, with which just the right amount of ozone is made and distributed from there to the various units.

Carbon Dioxide Compressors Used

The necessary refrigeration for cooling the building, equivalent to the melting of 250 tons of ice every 24 hours, is supplied by two double acting two-cylinder compressors located in the basement. The refrigerant used is carbon dioxide, which is compressed and circulated in liquid form. Entering a stack of double-pipe condensers of 288 pipes, 20 ft. long, the gas is liquefied and then by means of welded piping is conveyed to the various units or stations in the building.

Refrigerant Piped to Every Other Floor

It was found expedient and economical to pipe the refrigerant to substations located on every other floor. There are seven of these substations on alternating floors throughout the building, each station serving two floors with the exception of the unit on the thirteenth, which serves the thirteenth, fourteenth, and fifteenth floors. A separate unit serves the club rooms on the roof of the motor ramp adjoining the office building.

Each cooling unit consists of an air washer, a fan with capacity of 1,100 cubic feet per minute, a 260-gallon per minute pump, 1,000 square feet of direct expansion coils, and the heater surface. The direct expansion coils keep the water at a temperature of from 32 F to 45 F, depending on the particular conditions required in the building at any given time.

One Outlet per 100 Sq. Ft. of Floor Space

The fan of each unit is connected with a direct system distributing the air to the different offices, from which it is returned through louvered doors and corridors to the washer. The duct work which distributes the air after it has passed through the conditioning unit is concealed in the ceilings, with especially designed air outlets in each room. The system in general is laid out with one outlet to serve each 100 square feet of floor space, or about 900 cubic feet of room space, the openings being as close as possible to the center of the area to be supplied. By this means even distribution is assured. The air outlets are located just above the lights, and form a part of the lighting fixtures.

Air Is Recirculated

After entering and serving the various rooms, the air passes into the corridors and back to the air conditioning chambers, where it is mixed with the proper amount of

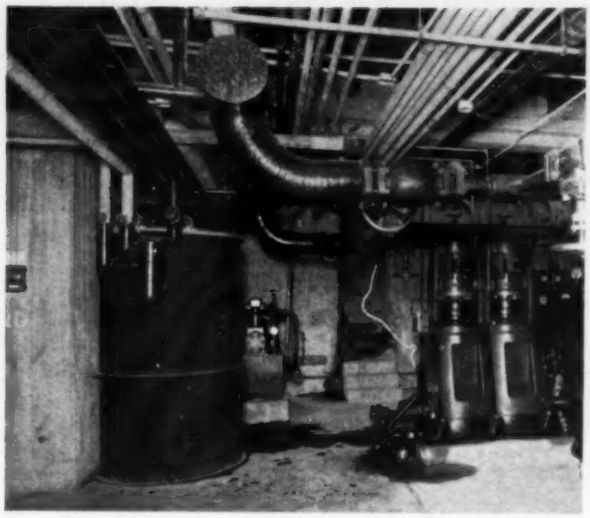


FIG. 4—THE DRINKING WATER COOLING TANK AND COMPRESSOR IS SHOWN TO THE LEFT. ONE OF THE 125-TON COMPRESSORS MAY BE SEEN AT THE RIGHT.

air drawn from the outside and the mixture of recirculated air and fresh outside air is passed through a fine mist of cold water in the spray chamber, again eliminating dust or other foreign matter and lowering the temperature to the proper degree for redelivery to the offices.

Indoor Temperature Balanced with Outdoor

The air in the offices is completely changed once every eight minutes under normal conditions. Each unit is separately controlled by means of thermostats by which the temperature of the air in each unit is maintained within 1 F of any desired point; humidity is also controlled. These unit instruments, in turn, are controlled by means of a synchronizing master control by which the temperature of the entire building is raised or lowered as the outside temperature rises or falls, a temperature of 12 to 15 F below the outside temperature being maintained for all outdoor temperatures above 85 F, with a relative humidity of about 55 per cent at all times.

During the heating season the same system of thermostatic control is automatically maintained, the refrigerating system being cut off and steam turned into the heaters, a temperature of approximately 70 F being maintained regardless of the outside temperature.

Occupants of the offices in this building are finding that the nicely adjusted temperature and humidity and the cleaned air afford the best of working conditions, and members of the Austin Club find the air and temperature conditions ideal.

There is much asthma and hay fever in Austin and the surrounding country, said to be attributable largely to the extensive cedar forests nearby. Visitors to the doctors' offices in the Norwood building have found such marked relief from these conditions during their brief stays in the building that a number have asked and secured permission to remain for definite periods each day in the reception rooms and the club rooms. Some of the permanent occupants of offices who have suffered from these troubles unhesitatingly state that they have improved noticeably in health during their occupancy of the air conditioned building. Similar reports are made from those having offices in the Milam building at San Antonio.

The air-conditioning system of the Norwood building was installed under the supervision of Lloyd D. Royer, consulting engineer, of San Antonio, and Giesecke & Harris, architects, of Austin, the contractor and builder being Frank R. Barron, of Austin.

Coolers Maintain Uniform Temperatures

IN THE plant of the Bowman Dairy Co., Chicago, the milk enters the cold rooms after going through the pasteurizing process, being cooled to 46 F in baudelot coolers just before entering. It is held from 12 to 24 hours in the distributing station, as it is loaded on the delivery trucks from time to time as they are ready for the different routes. At the end of the day, any full cans remaining from the previous day are shifted over

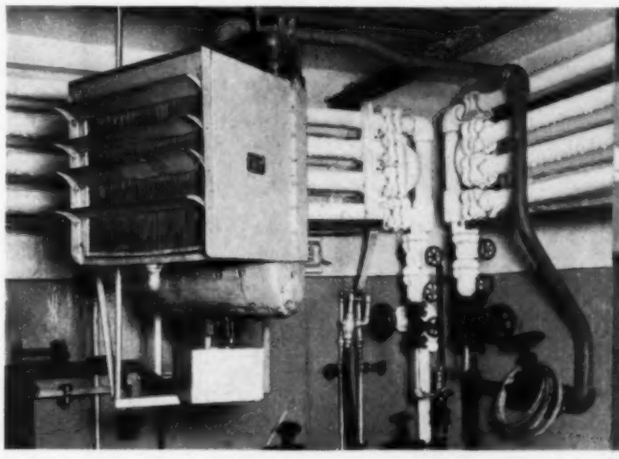


FIG. 1—ONE OF THE HEAT EXCHANGERS INSTALLED IN THE COLD ROOM OF THE MAIN DISTRIBUTING STATION OF THE BOWMAN DAIRY COMPANY, CHICAGO

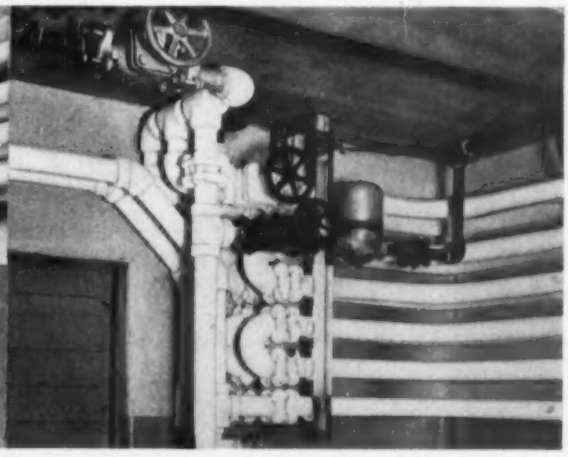


FIG. 2—THE AUTOMATIC PACKLESS VALVE, WORKING FROM AN AUTOMATIC SWITCH, MEETS THE DEFROSTING PROBLEM BY OPENING AND CLOSING THE AMMONIA SUPPLY

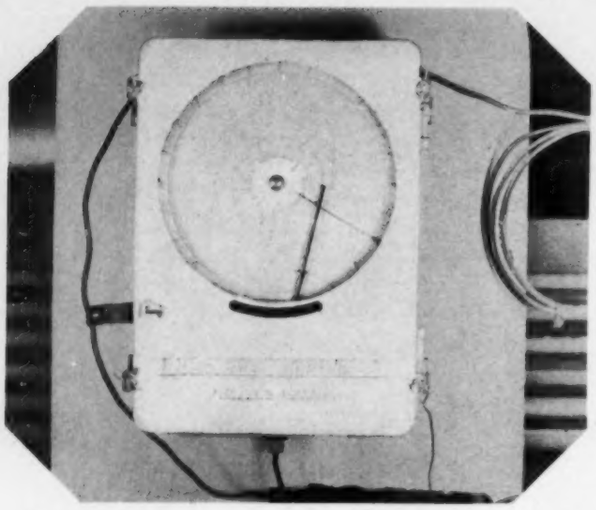


FIG. 3—THE TEMPERATURE RECORDER, LOCATED IN THE CORNER OF THE ROOM DISTANT FROM THE COOLER

to a special section of the room and disposed of.

The job this installation has to perform is to keep 170,000 lb. of milk a day at the right temperature to insure its reaching the big hotels, restaurants and other large customers of the Bowman Dairy Co. in perfect condition. This demands absolute dependability of the refrigerating equipment.

There are two inter-connected cold rooms which must be kept at a constant temperature of 40 degrees, day and night, summer and winter. With increased production, the refrigerating pipe coils originally installed became inadequate. Fogginess in the rooms was also a problem.

To supplement the pipe coils and to eliminate fog, two unit coolers were installed of the type illustrated in Fig. 1. This installation, in turn, presented the problem of frequent defrosting of the units, so this led to the use of an automatic packless valve, illustrated in Fig. 2, which opens and closes the ammonia supply to the units at the proper time interval.

Pipe Coils Carry Part of Load

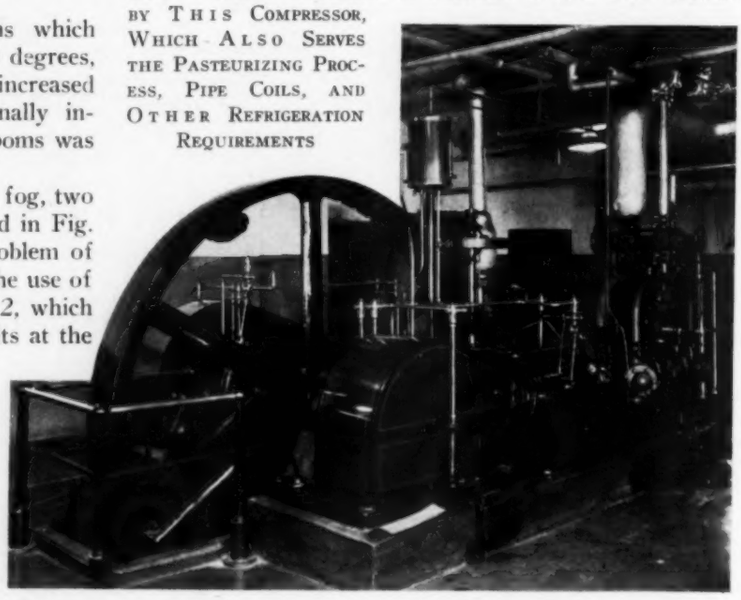
As will be noted in Fig. 1, pipe coils carry part of the cooling load, the unit coolers being installed when it became necessary to meet an increased load. The units have been in operation since last August and no difficulty has been experienced in maintaining the 40-degree temperature required despite the high out-door temperatures which have since been registered.

The unit shown in Fig. 1 circulates 3000 c.f.m. No outside air is provided except that which leaks through the doors. The units circulate the air throughout the room, maintaining a uniform temperature from floor to ceiling and in each corner, and entirely dissipating the fog which was formerly present. Ammonia is supplied the units at 16 degrees. Fig. 4 shows one of the 25-ton compressors.

The valve shown in Fig. 2 is connected to an automatic switch which closes the valve and cuts off the refrigerant when frost accumulates and opens the valve, permitting the refrigerant to flow, when the frost is removed from the cooling units. The photograph shows the valve during one of the periods of defrosting, the ammonia supply line in Fig. 2 and the unit in Fig. 1 being free from frost in the illustrations. During the defrosting period heat continues to be absorbed by the frost on the coils liquefying, which was figured in maintaining the uniform 40 F air temperature.

Fig. 3 shows the temperature recorder installed about two-thirds of the distance from the floor to the ceiling and in the far corner of one of the cold rooms from the unit. The uniformity of the curve is quickly apparent.

FIG. 4—A 25-TON AMMONIA COMPRESSOR LOCATED IN THE ENGINE ROOM. AMMONIA IS SUPPLIED TO THE UNIT COOLERS BY THIS COMPRESSOR, WHICH ALSO SERVES THE PASTEURIZING PROCESS, PIPE COILS, AND OTHER REFRIGERATION REQUIREMENTS



Bugs

A metropolitan newspaper recently printed a dispatch from Berlin stating that a new kind of metal-eating bug is believed to be in a large degree responsible for leaking metal pipes and tanks. This, according to the report, was born out to some extent by research conducted at the *Kaiser Wilhelm Institute* of that city.

This has caused a number of readers of this publication to send in inquiries as to the character of these bugs. W. C. Mattox intimates that it would be just too bad if some of these nasty bugs should eat a hole through a 1500-lb. steel valve under 1200-lb. pressure at 900 F, ruin our power piping and cause death and destruction all over the country.

A bug that can withstand such temperatures and pressures would indeed be a hardy specimen and doubtless would save a great deal of money in boring holes in boiler plates. Several engineers have discussed the formation of a business organization to round up a colony of these bugs and train them, although this might add to the technological unemployment problem. They doubtless have many other possibilities and if these bugs in the Institute can be equipped with iridium or diamond-tipped mandibles, the oxy-acetylene or electric cutting torch soon may become a thing of the past.

INTERVIEWS OF INTEREST

Dust Recovery an Engineering Specialty

Everyone objects to the "dusty" smell of stale atmosphere. Nevertheless there are few people who pause to consider that air dustiness may mean anything from the presence of sharp slag from fused ash of furnace fires to organic particles less than a micron in diameter, and that fumes are fumes because they carry solids recoverable as dust. The tar in coal smoke may be dense and prevalent enough to deposit 36 tons per square mile every year and yet do less damage than a microscopic dust that passes all unnoted.

And this is why the engineer regards all dust as finely particulate matter in suspension and dust control as a procedure that must await full study of what dust he deals with, what place it comes from, what forces tend to keep it in suspension, what industrial processes make it necessary, what measures may be considered as physically possible and economically practicable for its control.

To speak of dust as air pollution and fight it as a public nuisance merely begs the question. Dust can't be legislated out of existence as a nuisance except as science solves the problem and communities at large become dust conscious.

Dust *is* a nuisance. Some common dusts are serious dangers to the public health, but programs fail that have no facts to answer questions such as these: What kinds of dust? How much? What size of particles? What governs their suspension? Where are they carried? What means is rational for their control?

Air hygiene, then, is a challenge to engineering science. George A. Gieseler, Cleveland, Ohio, specialist in dust recovery and designer of apparatus in use extensively within the chemical and metallurgical trades, says:

Valuable Chemicals Recovered

"It is a logical thing that precision work in dust recovery was first employed in chemical trades where valuable chemicals are processed and recovered from fumes; and in metallurgical industries where furnace gases waste the finished product or constitute a menace through the fumes emitted. We filter furnace gases and recover non-ferrous oxides. We handle potash without dust or waste. We load and store fine potash, soda ash, and the like. We remove abrasive dusts.

"Dust recovery in coal grinding is readily accomplished with immense economic gain. In the metallurgical industry, a recent apparatus costing $1,000,000 to install paid for itself within three years, plus 20 per cent on the investment, because of savings effected through recovery.

"Dust recovery in chemical and metallurgical industries becomes a gas filtration process. Fumes that escape from some vital part of the process carry zinc, lead oxide, or arsenic. The fumes must be controlled. Recovery of by-products makes it highly profitable to employ the utmost refinement in air hygiene.

"Fumes are seldom entirely gaseous. They bear a load of microscopic solids in suspension. Fabric filters separate out metallic dusts where particles are 50 to 100 times smaller than the particles that will pass 300 mesh screens. The filter bags are automatically shaken free of filtered dust, and the dust in turn conveyed by means of a pneumatic conveyor and transported to storage bins or packed directly where it has been collected.

G. A. Gieseler

"The pneumatic conveyor used for transport then must have attention. A separate set of filtering devices removes all dust from the conveying air before it can be finally discharged into the outdoor atmosphere.

"Pneumatic conveying of lead oxide, potash, soda ash, nitrates, and many other commercial products for shipping or for process work within the plant is another phase of dust engineering. It saves materials and men in many cases and speeds the process work.

"Dozens of industries served and dozens of different problems encountered in dust work have meant research and new development. Dust control is a wide and ever-widening field of engineering activity. There is and can be no rule-of-thumb dust control. There can be no prescribed standard unless the situation to be handled has preliminary study. The fundamental problem is the same throughout. Whether the foreign particles in the air are fine ash from the furnace that burns powdered coal; valuable metal to be recovered from blast furnace gases; asthma-producing organic dusts; or some drug precipitated from chemical retorts—in every case there is research on problems that call for apparatus that has to be engineered through. Test-outs are called for in nearly every case, and installations must be checked and serviced.

A Common Problem

"Dust recovery as a specialty in engineering is not more than twenty years old. It represents a refinement in manufacturing technic and is logically a late development in industrial method. It is a poor conception of air hygiene to think alone of common dusts in outdoor air. Dusts that are harmful can and should be traced to the source. Dust collecting methods can be suited to the situations that arise, and any recommendations made should be rational and economical. Dust recovery, whether for esthetic or economic gain, still requires much to be done in fundamental research. It is a common problem for all engineers."

A Climate Factory for Concrete

In the studies of strength, durability, volume change, water-tightness, and other qualities of concrete blocks and cylinders continuously carried on at the *Portland Cement Association Laboratories,* Chicago, climate is

made for concrete, not concrete for the climate, thus reversing the usual order.

F. R. McMillan, director of research, and a staff of engineers, publish many authoritative volumes on the findings of this research center. Preliminary planning of research studies is given much attention so that the subjects investigated will be covered thoroughly. This means at times that a single study will involve controlled conditions for ten thousand specimens and tests that run for several months or years.

F. R. McMillan

"All the work that goes through this laboratory lies in the realm of pure research," states Mr. McMillan. "The studies undertaken are based upon problems that confront the entire concrete industry. Problems of the individual members of the Association are not taken up in the Association laboratory. Our research workers make their own test specimens, and the cements they utilize are all purchased in the open market.

Range of Tests

"The resistance of concrete structures to weathering, to the penetration of moisture, to heat transfer, and other factors relate so definitely to curing conditions, water content of the mix, and other physical factors susceptible to control that the technical man must know precisely how these things affect his final results. Recording wet and dry bulb thermometers and potentiometers, therefore, are used extensively in this laboratory, and automatic regulators serve to maintain desired temperatures for various tests from as low as 20 degrees below zero up to 2,000 F.

The General Laboratory

"The general laboratory or 'making' room has temperature around 70. A minimum relative humidity of 50 per cent is maintained by means of two humidifiers. The moist, or 'curing' room, receives blocks, briquets, or cylinders after they have been hardened in the molds for twenty-four hours. The curing room is 15 by 12 feet and has room enough for 30,000 specimens to be cared for at the same time.

The Curing Room

"The relative humidity in the curing room is kept at 100 per cent through the use of air nozzle atomizers. Under this condition men can work there without getting too wet; yet it protects the manufactured pieces of concrete against losses of moisture to the air. Temperature is held constant at 70 F. A special heating unit under thermostatic control is turned on automatically at any time that the central heat supply fails or is shut off, and another provision nearing completion now will attach a cooling unit to this room for still greater precision of control. The water spray is created by means of six compressed air nozzles at 30 pounds per square inch pressure. The auxiliary heating pipes are hot water, gas heated.

Studies on Durability

"Studies on the durability of concrete are conducted in a refrigeration room with refrigerating apparatus installed in a room insulated with 6-in. cork laid up in portland cement mortar. This represents a recently expanded apparatus that formerly was served by self-contained refrigeration units. The air temperature within this room can be reduced to 40 below zero. The specimens undergoing test are submerged in water and frozen solid. They are then thawed in warm water and again allowed to freeze. The alternating extremes go on until the specimens show signs of failure. All samples are carefully studied periodically and reported and rated according to their endurance records.

Unit Conditioner Used

"Another room within the laboratory is conditioned separately by a small unit air conditioner to give a temperature of 70 F and 65 per cent relative humidity throughout the periods when specimens for testing are being made. The specimens made in this room are introduced into the moist room by means of directly communicating windows. An examination of temperature and humidity charts from three recording wet and dry bulb thermometers gives one a wholesome respect for attentive care in testing work and for precision air conditioning methods in general.

"Air conditioning within the room where volume change is studied maintains a 70 F temperature and 50 per cent relative humidity. The humidity especially must be constant. The control device is used to turn on air currents from the moist room when necessary, or throws air currents over beds of calcium chloride for purposes of dehumidification if humidity rises above the required degree.

Fire Tests of Walls

"Fire tests are made of wall units of concrete. One side is exposed to gas flames which increase the temperature at a predetermined rate to approximately 2,000 F in three hours. Seven points for readings are connected with an automatic recording potentiometer which indicates the average furnace temperature. An equal number of thermocouples indicate the temperature within the wall, while as many more are located on the outer or unexposed surface."

One hears of "pure" science as the exclusive affair of academic groups, but evidence seen in a single inspection trip through industrial laboratories such as that maintained by the *Portland Cement Association* is proof enough that commercial tests also have only one objective: to find and recognize true things from false in the day's work.—*S. P. M.*

Volume Changes Due to Variations in Moisture Content Are Measured

Performance Data *for* Forty-Seven University Buildings *on* North Carolina Campus

By I. W. Summerlin*

Concise performance data on the heating of buildings, especially a group of buildings such as that at the University of North Carolina, are seldom available. But when available, they furnish a check which is of value in anticipating performance in heating installations under conditions similar in character.

The author presents in this article, among other information, performance data on a group of 47 university buildings.

LOCATED on the campus of the University of North Carolina at Chapel Hill are the oldest state university buildings in the United States, the first being Old East, constructed in 1793.

Approximately $5,000,000 have been spent in the last nine years on this campus, in the construction of 18 major buildings, in remodeling, renovating and making additions to old buildings and in the purchase of equipment. Altogether the buildings number forty-seven.

Many Years of Inadequate Heating

From the time Old East building was constructed (in 1793) until 1858, no attempt was made to heat the buildings on the campus by means other than the open fireplace. From historical data we learn that boilers subsequently were placed in the basement of each building and a hot water system installed. This plan proved a failure, the rooms near the boilers being too warm and those at a distance being too cold. After much expense the hot water system was discarded, not because the principle was faulty, but because there was a defect in the work.

Improvements were made in 1901 by the installation of a hot water system with forced circulation. This was a single-pipe shunt circuit system supplying heat to the buildings. A 5-in. pipe loop was laid underground in wood conduit, circulation through the radiators being induced by gravity from the shunt lines installed in each building, the supply and return risers being taken from the same main. Circulation was induced in the closed system by two engine-driven circulating pumps. Boiler tests conducted in 1911 showed low efficiencies, the average being 36 per cent.

The Present Heating System

In the present system heat is supplied to all but eight of the forty-seven buildings by a forced circulation hot water system. The direct cast iron column radiation used is located under windows. The radiation in the laboratory section of the chemistry building is the wall type located on inside walls due to space limitations on the outside walls, but in most buildings where the basement is heated, ceiling radiators or pipe coils are installed. Mains are left uncovered in many cases to act as prime heating surface, and all radiators are exposed except in the social room of Graham Memorial building and the reading rooms of the new library, where they are concealed.

The radiation installed in buildings constructed prior to 1915 was insufficient to heat them properly, and additional radiation was installed from time to time in an attempt to offset this condition.

Heat Losses Calculated from A. S. H. V. E. Guide Data

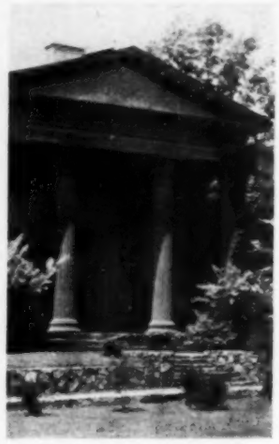
The heat losses from buildings constructed since 1921 were calculated from heat transmission coefficients as published in the *Guide* of the *A. S. H. V. E.* The heating calculations for buildings constructed between 1921 and 1924 included an allowance of one air change per hour for dormitory rooms, two air changes for seminar rooms and three air changes for class rooms. In the heating calculations for buildings constructed since 1924, infiltration losses were taken from the *A. S. H. V. E. Guide,* and added to other losses. Infiltration losses were checked against air changes per hour and in no case was less than one air change used. Infiltration was based on a 7.5 mile wind velocity, this being the average wind velocity for the section for the heating season, as shown in the *U. S. Weather Bureau Reports.*

The lowest temperature for the period of record, 36 years, is minus 6 F. Since this temperature is rarely reached and is usually of short duration, the minimum outside temperature assumed was 10 F, or 16 deg. above the lowest recorded temperature. The prevailing wind direction for the heating season is west. The inside breathing-line temperature (measured 5 ft. above the floor and 5 ft. from the outside wall) was assumed to be 70 deg. for all buildings except the filter plant, greenhouse and Venable Hall, where a maximum difference of 50 deg. between the inside and outside air temperature was assumed. A difference of 70 deg. was assumed for the Infirmary.

* Mechanical Engineer, Chapel Hill, N. C.

Approximately $5,000,000 have been spent in the last nine years on this campus, in the construction of 18 major buildings, in remodeling, renovating and making additions to old buildings, and in the purchase of equipment.

Table 1 shows the present continuous load on the central heating plant to be 230,410 sq. ft. of equivalent hot water radiation, including uncovered mains and risers. On an average there are 39 cubic feet of heated space for each square foot of radiation for all buildings heated from the central plant including Memorial Hall and the indoor athletic building. The ratio for seven of the old buildings (those not renovated) is 56 to 1. Since the construction and use to which these buildings is put is not materially different from other buildings, it is evident that these buildings are "under-radiated." The low ratio for the greenhouse is due to the large glass surface, whereas the high ratio for the gymnasium is due to the low temperature required.



The Chemistry Building has the split system, using direct radiation to offset radiation losses and a fan blast for furnishing heat and ventilation for providing a 6-minute air change in the laboratories.

All buildings are heated by hot water except the buildings department, filter plant, greenhouse, infirmary, indoor athletic building, new library and Memorial Hall. As the hot water circulating pumps are shut down at 10:30 p. m., except in extremely cold weather when they are run all night at reduced speed, it was deemed advisable to place the greenhouse and infirmary on a steam line, as they require continuous heat. The installation cost of the steam line to the infirmary was low, as steam was required at Swain Hall, near by, for kitchen use and for heating water. The greenhouse is adjacent to the boiler room, which affords an economical supply line.

Memorial Hall requires a large amount of heat in peaks of short duration which would have required an unwieldy piping system had it been supplied with hot water heat. The filter plant is adjacent to Memorial

TABLE 1—HEATING DATA, UNIVERSITY OF NORTH CAROLINA BUILDINGS

1	2	3	4	5	6	7
Building	Volume Heated in Cu. Ft.	Ratio Cu. Ft. to Sq. Ft.	Radiation Surface Square Feet			Equiv. Hot Water Rad.
			C. I.	Pipe	Total	
Alumni	246000	47	3533	1280	4813	5230
Battle—V.-P.	192500	32	5420	400	5820	5960
Bingham	198000	33	5882	90	5972	6000
Buildings Dept.	19200	25	370	80	450	770S
Caldwell	307200	59	4000	880	4880	5170
Carr	144000	45	2738	350	3088	3210
Davie	184000	34	4836	400	5236	5470
Dormitory B	173000	41	3609	435	4044	4190
Dormitory C	173000	41	3609	435	4044	4190
Dormitory D	173000	41	3609	435	4044	4190
Dormitory E	173000	41	3609	435	4044	4190
Dormitory F	165900	38	3760	450	4210	4360
Dormitory G	165900	38	3760	450	4210	4360
Dormitory J	165900	38	3760	450	4210	4360
Dormitory I	165900	38	3760	450	4210	4360
Filter Plant	49100	27	780	260	1040	1810S
Gerrard	56200	71	100	524	624	790
Graham	60400	66	920(a)	700(b)	1620	1670
Greenhouse	8900	12	0	338	338	720S
Gymnasium	247000	127	1420	400	1820	1950
Indoor Athletic	.....	.....	FANS	500	.....	5000SF
Infirmary	109300	26	2246	250	2496	4130S
Library (Old)	244000	72	3001	300	3301	3400
Library (New)	975000	53	10947	400	11347	18500S(c)
Manning	260000	45	5006	610	5616	5820
Memorial Hall	520300	46	Fan—3 Air Changes—			11180SF
Murphey	305600	37	7160	870	8030	8320WB
New East	185400	38	4730	70	4800	4820
New West	137000	35	3827	50	3877	3890
Old East	146000	50	2532	300	2832	2930
Old West	146000	50	2542	300	2842	2940
Peabody	234000	48	4200	500	4700	4870
Person	97200	34	2745	100	2845	2880
Pharmacy	263000	49	4068	950	5018	5330
Phillips	597450	37	13318	1990	15308	15970
Playmakers	104700	49	1909	170	2079	2130
President's House	.....	.....	1295	100	1395	1430Ind
Saunders	292000	37	6843	820	7663	7930WB
Smith Dormitory	133500	33	2935	865	3800	4090
South	251000	40	5420	600	6020	6220
Stadium	109500	42	2120	380	2500	2630
Steele	168500	42	3100(d)	700	3800	4030
Swain	257000	63	3880	40	3920	3930
Venable	845000	48	12240	2260	14500	40700WF
Woman's Building	131700	32	4040	40	4080	4100Ind
Y. M. C. A.	101700	51	1747	190	1937	2000
Total	9682950	39	171326	22597	193423	252120
Individual	131700	.....	5335	140	5479	5530
Heated from Central Plant	9551250	.....	165991	22457	187944	246590
Memorial Hall	520300	.....	Fan—3 Air Changes—			11180
Indoor Athletic	.....	.....		Fans		5000
Continuous Load	9030950	39	165991	22457	187944	230410

Table 1 includes all buildings constructed to the first of the year 1930. Bingham, Dormitory I, Indoor Athletic and the new Library have been added since the end of the year 1927.

S—indicates steam. SF—steam heat by fan (average 1 hr. per day). WB—water heat and ventilation by fan (Extended surface radiation not included in radiation as not used.) WF—water heat and ventilation (Extended surface radiation included = 23,000 sq. ft. equivalent hot water radiation). IND.—individual hot water plant.

Col. 2—Actual heated space.

Col. 3—Col. 2 ÷ Col. 7.

Col. 5—Includes pipe coils, exposed mains and risers.

Col. 7—Based on average cast iron column radiation used at U. N. C. = 150 Btu per sq. ft. per hr. For wall radiation added 20 per cent, pipe 33 per cent, steam 60 per cent.

(a) 25 per cent added to actual requirements account radiator enclosures. Equivalent cast iron radiation = 735 sq. ft.

(b) Exposed pipe in unheated space.

(c) Fan blast units in stack room not included. (Fans used for recirculating only).

(d) 3,500 sq. ft. in building, 400 sq. ft. in basement not connected.

Hall and it was therefore more economical to heat this building with steam than with hot water. It is necessary also to maintain a uniform temperature in this building for the proper operation of certain of the equipment.

The new library was equipped for heating with steam for the following reasons: (1) The exposure in the stack room due to large glass surface would have afforded a possibility of breakage in the radiators due to freezing with consequent damage to books from the water, (2) an excessive amount of radiation would have been required in the reading rooms to provide a quick heating-up period, due to the large volumes heated, and (3) the temperature in the reading rooms would have been difficult to control due to the excessive amount of radiation.

Temperature regulation in the buildings heated by hot water is accomplished by varying the temperature of the water leaving the power house in accordance with the outside temperature.

The design of the hot water heating system (since 1924) was based on carrying a mean temperature of 170 F in the radiators with a 20-deg. drop which requires an initial temperature of 180 F with the outside temperature at 10 F. The difference between the temperature of the water in the radiators and the air temperature of the rooms is 100 deg., and the average amount of heat liberated from all the hot water radiating surfaces installed is 1.5 Btu per sq. ft. per hr. per deg. difference in temperature between the inside and outside of radiator, assuming the radiator to be placed in still air. With a 100-deg. difference, the average radiator installed emits 150 Btu per sq. ft. per hr.

Underground Heating Mains

The underground heating mains consist of a supply and return pipe of the same size run together in concrete trenches and terra cotta conduits. Circulation is by means of a centrifugal pump placed in the power house, the water being forced through heaters supplied with either exhaust or live steam. A centrifugal circulating pump having a capacity of 2,600 gal. per min. when pumping water at a temperature of 180 F and operating against a 162-ft. head forces the water through a vertical four-pass heater, the water passing through 1-in. copper tubes. The heater was designed to heat 2,600 gal. per min. through a temperature range of 27 deg., or from 153 to 180 deg. when supplied with steam at 2-lb. gage. The temperature difference of 27 deg. is required to offset the 20-deg. drop in the radiators and the heat loss from piping, pumps and heaters.

Two trunk lines supply all buildings connected to the system, branch lines running from trunk line through the basement of each building from which supply and return risers are taken to floors above. Circulation in the risers and through the radiators is induced by gravity. A lock

FIG. 1—THE PUMP ROOM AT THE UNIVERSITY OF NORTH CAROLINA POWER PLANT. THE PUMP IN THE LEFT FOREGROUND IS FOR SERVICE WATER; IMMEDIATELY IN BACK OF IT IS THE FIRE PUMP. THE OTHER THREE SHOWN ARE HOT WATER CIRCULATING PUMPS

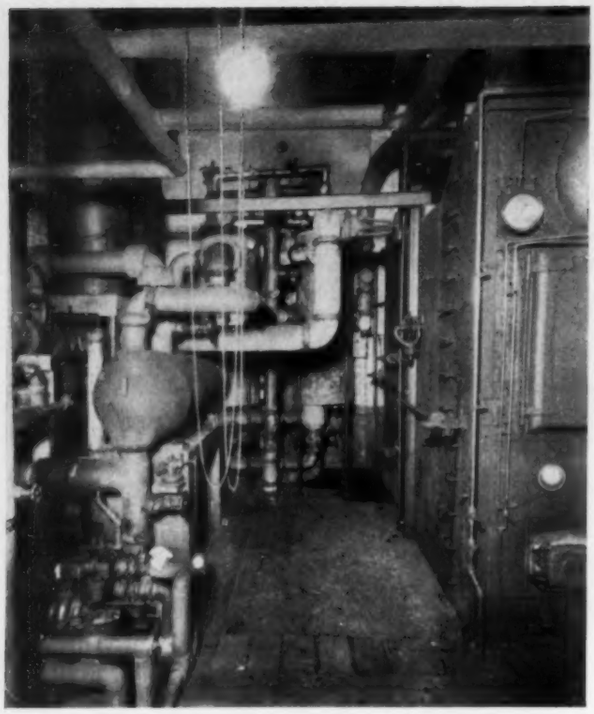


FIG. 2—THE BOILER ROOM. IN THE LEFT FOREGROUND ARE THE BOILER FEED PUMPS. HEATERS FOR BUILDING WATER AND EXPANSION TANKS FOR THE HEATING SYSTEM MAY BE SEEN IN THIS VIEW, IN ADDITION TO A GLIMPSE OF THE BOILER

shield valve is placed on the supply line to each building for regulating the flow, thermometer wells being installed in the supply and return pipes for use in determining the drop in temperature in each building.

In laying out the piping in any particular building, care was exercised to provide that the incoming water be directed toward the side of the building having the coldest exposure, thus balancing the radiation throughout the building. No additional radiation is required to offset the reduced temperature of the water on the outgoing side of the building. The factors used in figuring the additional radiation required on the sides having the coldest exposure offset this reduction in the temperature of the outgoing water.

All underground piping in trenches is covered with 1½-in. thick sponge felt covering finished with 3-ply roofing wired in place with No. 17 copper weld wire on 6-in. centers. Piping in conduit is insulated with asbestos sponge filler packed around the pipe. In general all mains 5 in. in diameter and smaller are installed in terra cotta conduit and larger mains are placed in concrete trenches. The average size of supply and return mains is 8 in., the size of the concrete trench for this size main being 18 in. deep by 30 in. wide. Since it is not necessary to grade the mains in a forced hot water system, the conduits follow the ground contour. The mains are welded from end to end, pipe bends being used to care for expansion.

In designing the underground heating mains, tables were prepared showing the quantities of water to be pumped between the junction points with the length of run and the velocity of flow through the pipe, from which the size of pipe and the frictional resistances for

TABLE 2—POWER PLANT LOG FOR 1927, SHOWING POUNDS OF COAL CONSUMED

Month 1	Total 2	Hot Water 3	Swain Hall 4	Mem. Hall 5	Misc. 6	Cols. 3-4-5-6 7	Bldg. Heat 8
Jan.	1356045	64930	30000	21000	80000	195930	1160115
Feb.	907000	98490	30000	11000	80000	219490	687510
Mar.	1020000	100800	30000	11000	80000	221800	798200
Apr.	733000	119800	30000	6250	80000	236050	496950
May	397000	69950	30000	1500	80000	181450	215430
June	175000	67100	25000	0	82900	175000	0
July	187000	81200	30000	0	75800	187000	0
Aug.	147000	32400	30000	0	84600	147000	0
Sept.	133000	28740	25000	0	79260	133000	0
Oct.	398000	74890	30000	2350	80000	187240	210760
Nov.	780000	81900	30000	7800	80000	199700	580300
Dec.	1403855	89160	25000	17100	75000	206260	1197595
Total	7636900	909360	345000	78000	957560	2289920	5346860

Col. 1—Calendar months.
Co. 2—Weights for calendar months.
Col. 3—Weights based on 1 lb. stm. per gal. of water heated.
Col. 4—Hot water and steam for kitchen, hot water for infirmary and Smith Dormitory.
Col. 5—520,300 cu. ft. × 0.15 lb. = 78,000 lb. per yr. Prorated from degree-days per month, from Col. 5, Table 3.
Col. 6—Engineering Lab., Chemistry Bldg., pumps and power plant losses.
Co. 8—Coal consumed heating buildings on central heating system in 1927 (except Memorial Hall). (Col. 2-7.)

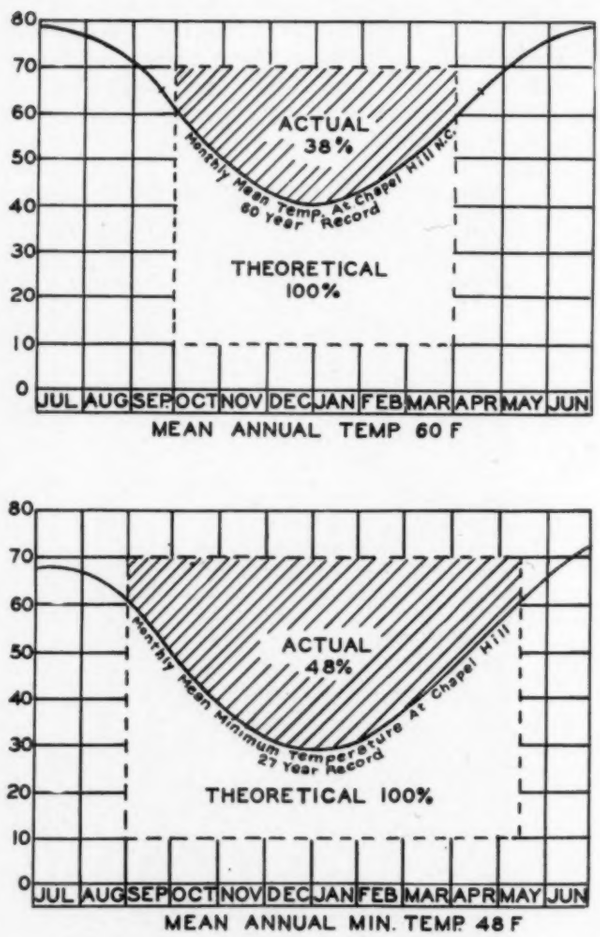


FIG. 3—ACTUAL AND THEORETICAL FUEL DEMANDS FOR A HEATING SYSTEM. WHERE CURVE INTERSECTS 60 DEG., THE DOTTED LINE SHOWS THE HEATING SYSTEM TO BE FROM OCT. 1 TO APR. 1, OR 182 DAYS

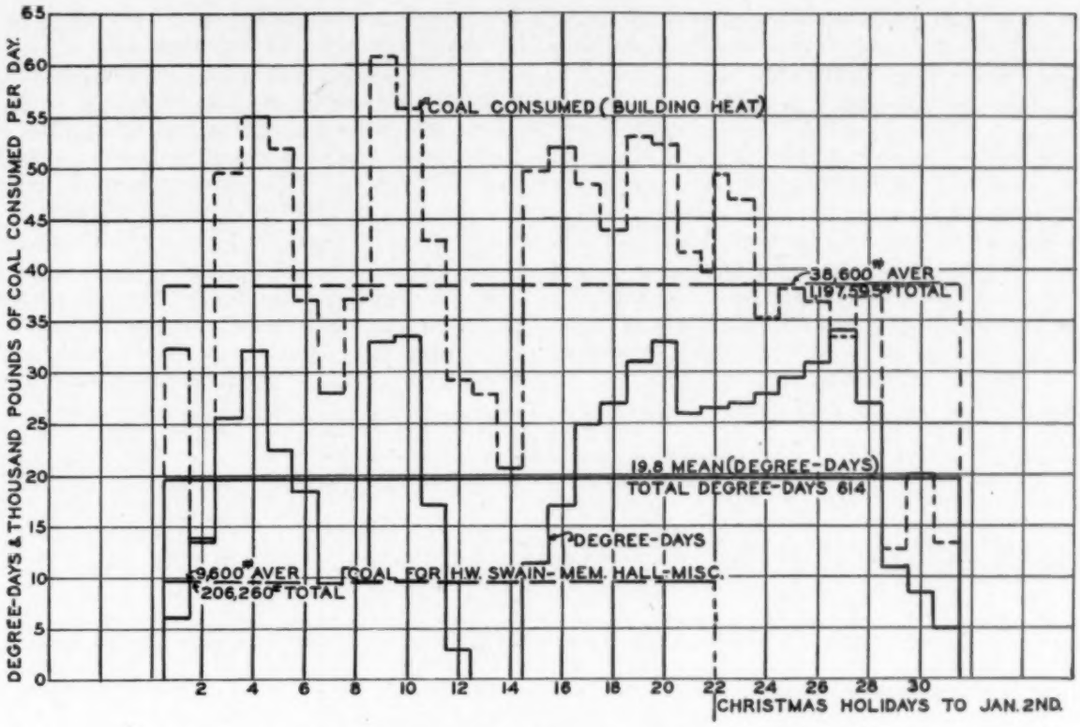


FIG. 4—HEATING LOAD CURVE FOR DECEMBER, 1927

the pipe, fittings and other obstructions were computed. The total frictional head is the head against which the pump operates, as the system is closed and the static head is balanced.

The volume of 180-deg. water required for heating the buildings with an outside temperature of 10 deg. is approximately 1 gal. per hr. per sq. ft. of equivalent hot water radiation based on 150 Btu transmission per hr. (8.1 lb. per gal. × 20 deg. ÷ 150 Btu per sq. ft. per hr. = 1.08 gal. per hr.).

Weather Conditions

The average heating season for Chapel Hill is 182 days, in which the mean temperature is below 60 deg. The mean temperature for the heating season is 48 deg. and the mean temperature for the coldest month is 42

TABLE 3—HEATING PLANT LOG, 1927

Month	Coal Consumed Pounds	Rad. Surface Sq. Ft.	Volume Heated Cu. Ft.	Degree Days Total	Degree Days %	Pounds Coal Per S. Ft. Rad.	Pounds Coal Per Cu. Ft. Vol.	Pounds Coal Per Deg. Day	Total Wind M'v't Miles Per Mo.
1	2	3	4	5		6	7	8	9
Jan.	1160115	143090	7351950	719	27	8.10	.158	1610	869
Feb.	687510	143090	7351950	375	14	4.80	.093	1840	755
Mar.	798200	143090	7351950	372	14	5.58	.109	2140	954
Apr.	496950	143090	7351950	213	8	3.47	.067	2330	864
May	215430	143090	7351950	43	2	1.50	.030	5000	797
June	.....	.....	.....	.....	.....	.....	.....	.....	.....
July	.....	.....	.....	.....	.....	.....	.....	.....	.....
Aug.	.....	.....	.....	.....	.....	.....	.....	.....	.....
Sept.	.....	.....	.....	.....	.....	.....	.....	.....	.....
Oct.	210760	153140	7692050	81	3	1.37	.027	2600	603
Nov.	580300	153140	7692050	285	10	3.80	.076	2040	781
Dec.	1197595	153140	7692050	614	22	7.80	.155	1950	1258
Total	5346860	.....	.....	2702	100	36.4	.704	.....	8881
Avg.	.....	146860	7475000	.....	.....	.....	.....	2010	.....

Col. 1—Calendar months.
Col. 2—Coal consumed heating buildings on central heating system in 1927 (except Memorial Hall), from Col. 8, Table 2.
Col. 3—Actual equivalent C.I. hot water radiation connected to central heating system in 1927 (inc. pipe coils), from Col. 4, Table 1.
Col. 4—Vol. heated from central plant in 1927 (except Mem. Hall), from Col. 2, Table 1.
Col. 5 and 9—From U. S. Weather Bureau Reports.

TABLE 4—HEATING COSTS, 1927

Month	Coal Tons	Coal Cost	Radiation Surface Sq. Ft.	Volume Heated Cu. Ft.	Deg.-Days	Cost Per 100 Sq. Ft.	Cost Per 1000 Cu. Ft.
1	2	3	4	5	6	7	8
Jan.	580	$3040	143090	7351950	719	$2.13	$0.42
Feb.	344	1800	143090	7351950	375	1.26	0.25
Mar.	399	2100	143090	7351950	372	1.47	0.29
Apr.	248	1300	143090	7351950	213	0.91	0.18
May	108	567	143090	7351950	43	0.36	0.08
June	.....	.....	.....	.....	.....	.....	.....
July	.....	.....	.....	.....	.....	.....	.....
Aug.	.....	.....	.....	.....	.....	.....	.....
Sept.	.....	.....	.....	.....	.....	.....	.....
Oct.	105	551	153140	7692050	81	0.36	0.07
Nov.	290	1520	153140	7692050	285	1.00	0.20
Dec.	598	3130	153140	7692050	614	2.04	0.41
Total	2672	$14008	.....	.....	2702	$9.53	$1.90
Avg.	.....	.....	146860	7475000	.....	.....	.....

Col. 1—Calendar months.
Col. 2—Coal consumed heating buildings on central heating system in 1927 (except Memorial Hall), from Col. 8, Table 2.
Col. 3—Coal cost at boilers $5.25 per ton.
Col. 4—Actual equivalent C.I. hot water radiation connected to central heating system in 1927 (inc. pipe coils), from Col. 4, Table 1.
Col. 5—Vol. heated from central plant in 1927 (except Mem. Hall), from Col. 2, Table 1.
Col. 6—From U. S. Weather Bureau Reports.

deg. The actual season's fuel demand (see Fig. 3) for Chapel Hill is 38 per cent of the theoretical demand, based on monthly mean temperatures.

Fuel Consumption

The distribution of coal in this plant for the year 1927 (see Table 2), shows that 2,672 tons were required for heating.

The heating load curve for December, 1927 (see Fig. 4), shows the manner in which the coal consumption varied with the number of degree-days. The total degree-days for the month was 614. The coal used amounted to 598 tons, or an average consumption of 1,950 lb. of coal per degree-day.

The heating plant log for 1927 (see Table 3) shows that 36.4 lb. of coal were required per sq. ft. of equivalent C. I. hot water radiation supplied and 0.70 lb. of coal per cu. ft. of space heated for the year. The average coal consumption per degree-day was 2,010 lb.

The cost of coal used for heating in 1927, based on the price of $5.25 per ton at the boilers (see Table 4) was $9.53 per 100 sq. ft. of equivalent hot water radiation, $1.90 per 1,000 cu. ft. of space heated.

No distinction was made in figuring these costs between buildings heated continuously and those to which heat was supplied for a limited number of hours each day. The buildings heated continuously were small in size and few in number, so the figures could well be considered applicable to the buildings on the hot water system.

Manufacture and Proper Use of Wood Products Require Air Conditioning

By W. LeRoy Neubrech*

FOR some unknown reason, wood has not received in the past due credit commensurate with its importance. Perhaps it was because it has been such a common, every-day material that its importance was not realized. Today, however, we find great strides being taken to demonstrate its significance. Research on all phases of wood production, manufacture and use has developed with inspiring rapidity. Every day finds greater emphasis being placed upon the proper and correct uses of wood, the conditions which make its use feasible and possible, and last, but not least, the proper care and treatment of wood products. It is with this last phase that this article is primarily interested. Successful use of wood in most instances depends upon proper air conditioning.

How Wood Dries

Green lumber cut from freshly felled trees contains a high percentage of moisture, ranging from 40 to 150 per cent for most of the commercially important species of wood, based upon its oven dry weight. Moisture in wood occurs in two distinct forms, usually termed "free" water and "imbibed" water. The free water is found inside of the individual cells, while the imbibed water is that absorbed by the cell walls. A part or all of the free water can be removed without changing the amount contained in the cell walls. When the point is reached where all the free water is removed from the cell and the cell wall starts to dry, it is known as the "fiber-saturation point." This point has a very important bearing upon the seasoning of wood. When the cell wall starts to dry out, the cell begins to contract in size and the wood begins to shrink. This critical point is usually reached at a moisture content of 20 to 35 per cent, based upon oven dry weight. In actual drying practice, however, it is seldom the case that the entire cross-section of a board will reach this point at the same time. The surface of the board is more often dried below the fiber-saturation point and shrinkage of the surface layers starts before the center of the board has reached the fiber-saturation point.

Unless intelligent kiln control is maintained, green lumber placed in dry-kilns can be quickly ruined. It is

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Acknowledgment is due U. S. D. A. Forest Products Laboratory publication, "Relation of Moisture Content and Drying Rate of Wood to Humidity of Atmosphere," as the source of data for parts of this article dealing with moisture content of wood in relation to humidity of atmosphere.

during the period of the removal of the free water that serious stresses are likely to develop which result in surface checking, and subsequent casehardening and honeycombing. Modern kilns, properly operated, can successfully dry green or partially dry lumber to a low moisture content without any of these serious losses.

Why Wood Is Dried

The chief reason for drying wood is to bring it to a point of equilibrium with moisture conditions under which it will be used. Wood shrinks or swells in accordance with changes in its moisture content when below the fiber saturation point. This property of wood is known as *hygroscopicity*. For example, wood for a chair is usually kiln-dried to about a 5 per cent moisture content, but will usually take on moisture to the extent of 6 or 7 per cent at the time it is completely manufactured, which is about the "mean" between the extremes of moisture content it may reach in use. In the winter, with dry heat in a building the wood in this chair may dry down to 4½ or 5 per cent with corresponding shrinkage, while in the summer with high humidities, it may take on moisture to the extent of 9 or 10 per cent, possibly more, with corresponding swelling. Wood should be dried to a particular "mean" moisture content to conform with the humidity of the atmosphere under which it will be used.

There are numerous other reasons why wood is seasoned before use. From an economical point of view it is vastly cheaper to ship dry or partially dry lumber than green lumber. In many instances a saving of $5 to $10 per 1,000 board feet results.

Green lumber is prone to stain, mold, decay or become insect infested while in storage or in transit. It is, therefore, cheap insurance against such possible losses to dry lumber promptly.

How Wood Is Dried

Most of the high grade softwood lumber produced is kiln-dried immediately after sawing, while the lower grades are air dried. Hardwood lumber is seldom kiln-dried at the source of production, as the producer is seldom in a position to know the exact use which the various buyers will make of the material. The lumber is, therefore, air dried at the saw-mill and then shipped to the consumer, who kiln-dries his lumber according to his own requirements.

Air-drying Lumber: It is seldom possible to air-dry lumber in the open air below a 15 per cent moisture content no matter how long it is kept. To air-dry lumber would seem to be a simple problem, but unless certain precautions are taken, serious loss and *degrade* results. Even lumber which has previously been air-dried can be quickly spoiled by improper piling during storage. Grounds for air-drying or storage should be well drained and covered with cinders to keep down any vegetation. Vegetation holds moisture around the base of the lumber piles, hinders or checks drying, and induces conditions favorable for decay. Foundations should be at least a foot high and properly constructed to allow for ventilation under and through the pile of lumber. Dry stickers should be evenly placed between each tier of lumber and a space about 6 inches wide up the center of the pile should be left as a chimney for circulation of air. Last of all, a good roof should be placed over the pile.

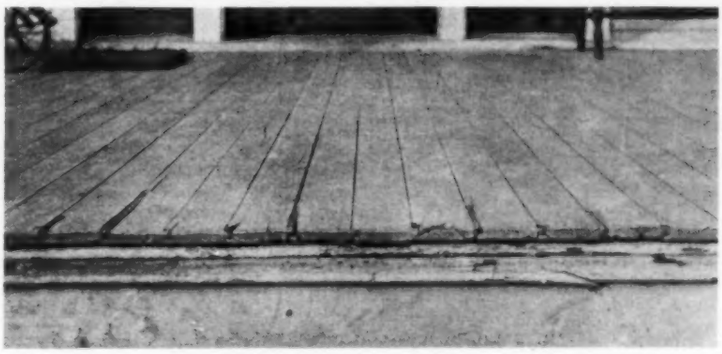


FIG. 1—A COMMON EXAMPLE OF THE RESULT OF CHANGES IN MOISTURE CONTENT OF WOOD WITH CORRESPONDING SHRINKAGE AND SWELLING. CONSIDERABLE FLOORING IS LAID TOO DRY, WITH THE RESULT THAT, DUE TO MOISTURE BEING ABSORBED FROM THE OPEN AIR AFTER IT IS LAID, WITH CONSEQUENT SWELLING OF THE WOOD, "COMPRESSION SET" IS DEVELOPED WHEREBY THE WOOD FIBERS ARE CRUSHED. SUBSEQUENT DRYING LEAVES THE WIDE CRACKS NOTED IN THE PICTURE

Kiln-drying Lumber: The art of kiln-drying lumber was developed to do in a week or two what nature alone could do in several months, and also, to do what nature could not do, to dry lumber down to a low moisture content for use under modern building conditions.

The art of successful kiln-drying of lumber is largely one of successful air conditioning. There are three important factors to consider in artificial drying of lumber: (1) Temperature of air, (2) Humidity of air, and (3) Circulation of air.

These three factors must be controlled with relation to each other. Some of the first kilns developed were merely hot boxes with little or no heed to circulation of air or to humidity. This resulted in heavy losses from the various defects previously mentioned. The next step in dry-kilns was the development of ways and means for creating circulation. In most cases it was accomplished by chimneys and flues, depending upon natural circulation of air. Further developments found artificial control of humidity being used. There are hundreds, if not thousands, of old fashioned kilns in operation today. Many of these were built to obtain control of temperatures, humidities and circulation, but are far from satisfactory. Hand control of these kilns, with the operator guessing at temperatures and humidities, results in very poor drying and heavy losses from degrade, not alone the loss of time and heat over the more rapid and efficient modern kilns.

Modern kilns are practically automatic in their control of the three important factors of temperature, humidity and circulation. Humidities are maintained usually by steam spray or water spray. Circulation is

obtained by artificial means, usually by the use of fans. Heat is frequently furnished by pipe coils, either inside the kilns or outside. Up-to-date direct-set recording regulators for temperature and humidities do most of the work for the kiln operator. In many types of kilns the circulation is also automatically controlled. All the operator need do is determine the moisture per cent of the wood he is going to dry and follow a predetermined schedule for the particular species of wood and thickness of lumber.

Before pulling the load of lumber from the kiln a final check is made of the moisture content of the lumber, also the evenness of dryness throughout the cross-section of a board. In many instances the average moisture per cent may be satisfactory, but the surface may

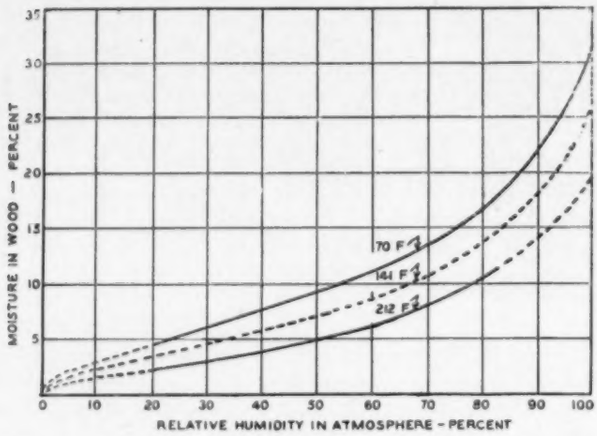


FIG. 2—RELATION OF MOISTURE CONTENT OF WOOD AND RELATIVE HUMIDITY IN ATMOSPHERE AT CERTAIN TEMPERATURES. (COPIED BY PERMISSION FROM U. S. D. A. FOREST PRODUCTS LABORATORY PUBLICATION: "RELATION OF MOISTURE CONTENT AND DRYING RATE OF WOOD TO HUMIDITY OF ATMOSPHERE".)

be over-dry and the core over-wet; or a vice versa condition. Such conditions can be corrected by proper regulation of humidity and temperature before the load is pulled. All kiln-dried lumber should be placed in dry storage for at least a period of a week before using in order to allow for relief of stresses and for evening up moisture distribution. This is termed *tempering*.

Relation of Dryness of Wood to Humidity

It has already been pointed out that the chief object of drying wood was to bring it to a point of equilibrium with conditions under which it will be used. Wet wood gives off moisture under ordinary atmospheric conditions and dry wood takes on moisture in damp weather. The result is a corresponding shrinkage and swelling,

TABLE 1—AVERAGE HUMIDITIES AT DIFFERENT SEASONS IN CERTAIN PARTS OF THE UNITED STATES. (TAKEN FROM U. S. D. A. FOREST PRODUCTS LABORATORY PUBLICATION, "RELATION OF MOISTURE CONTENT AND DRYING RATE OF WOOD TO HUMIDITY OF ATMOSPHERE")

MEAN RELATIVE HUMIDITY PER CENT	NEW YORK CITY	EL PASO, TEXAS	SALT LAKE CITY, UTAH	SEATTLE, WASHINGTON	MEMPHIS, TENNESSEE	SAN FRANCISCO, CALIF.	PHOENIX, ARIZONA
Winter	73	45	73	83	74	79	47
Spring	70	27	52	73	69	79	32
Summer	74	41	36	69	75	84	32
Fall	75	46	51	81	71	80	41
Annual Mean	73	40	53	76	72	80	38

known to mill-workers and other craftsmen in wood as "working." The result is that doors, sash and drawers stick in damp weather and become loose in dry weather. Wooden articles may check or the joints may open up when the humidity is low, or the wood may expand excessively and warp when subjected to high humidities.

Manifestly, it may be said that the lower the humidity, the faster moist or green lumber will dry and the drier it will become; while on the other hand, the higher the humidity, the faster dry lumber will take on moisture; although in both instances temperature has some influence.

Reference to the graph shown in Fig. 2 will illustrate the definite relation between the moisture content of wood and the humidity of the atmosphere at certain temperatures, when the wood has come into equilibrium. For example, wood exposed for a long enough period to reach an equilibrium at an 80 per cent relative humidity at 70 F will attain a moisture content of 17 per cent, while at a relative humidity of 20 per cent it would have only about 4½ per cent moisture content.

Table 1 shows how atmospheric humidities vary in different parts of the United States. By reference to Fig. 2 it is possible to estimate the ultimate dryness of wood at any particular place during the different seasons. For example, in New York City wood kept in the open atmosphere, but protected from snow and rain, would be at equilibrium with atmospheric conditions in the summer when at about a 15 per cent moisture content, while in Phoenix, Arizona, at about a 7 per cent moisture content, considering the temperature of the air to be about 70 F. Obviously, wood used inside of homes or buildings is not usually subjected to the extremes of

humidity indicated in this table, particularly when they are heated.

Relation of Air Conditioning and Wood

In Manufacturing Plants: Air conditioning plays an important part in the correct kiln drying of lumber and its proper storage before use. In re-manufacturing lumber into various wooden products a great deal of trouble is very often encountered in not keeping the humidity fairly constant throughout the plant. Lumber may be properly kiln-dried to a desired 6 per cent moisture content and properly stored in a dry shed at a humidity of 30 per cent at 70 F, but if taken into the average manufacturing plant it will change its moisture content with corresponding change in dimensions as it tends to come into equilibrium with the humidity of the air in the plant.

Many plants are found where there is a vast difference in humidity in different rooms. As modern manufacturing methods tend toward specialization, an article is seldom completely made and assembled in one room. Therefore, many individual parts may be fabricated in different rooms under different humidities. Even though these parts may be made from wood which was of equal dryness to begin, it may be that each piece will be of different moisture content when ready for assembly. The author has in mind a particular wood-working plant where these identical conditions prevail. Serious difficulties often arise by cracking or opening of joints, surface checking, and lifting of veneer.

In most instances, assembled wooden products, for example furniture, are put into the finishing room which is usually kept at a relatively high temperature of about 80 F with a resulting low humidity of about 34 per cent. The product will tend to dry down to around a 6 per cent moisture content. From this room the product goes to a storage room or shipping room with a temperature of perhaps 60 F and a relative humidity of 60 per cent, with the result that the wood can take on moisture to the extent of 12 per cent, a difference of 6 per cent. Corresponding swelling of the wood takes place.

In Buildings and Homes: When these same products later appear in the retail store, office building or home, it is likely they will again dry out. Checks may appear on the highly finished surfaces or the glue joints may open up. Changes in moisture content of wood take place slowly, especially when products are coated on all sides with varnish, shellac, paint or other protective coating. While the maximum change in moisture content of the wood may not be reached according to any particular humidity condition, change of only a small per cent is likely to cause difficulties.

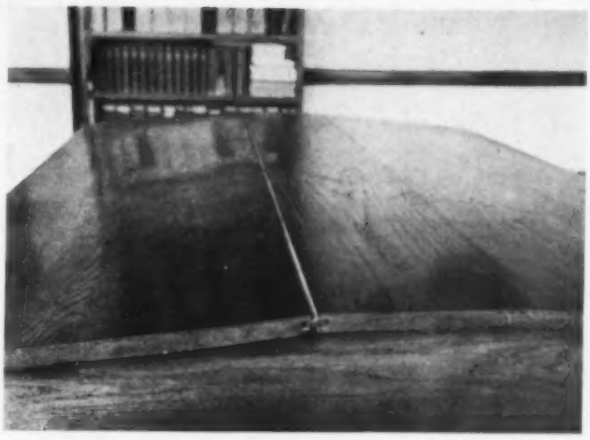


FIG. 3—OPENING OF A GLUED TONGUE AND GROOVE JOINT IN AN OAK TABLE DESK DUE TO SHRINKAGE OF WOOD AFTER MANUFACTURE. THE LUMBER WAS INSUFFICIENTLY DRIED TO MEET THE LOW HUMIDITY OF THE AIR DURING THE WINTER MONTHS WHEN THE SO-CALLED "MODERN OFFICE BUILDING" WAS MERELY HEATED, WITH NO AIR CIRCULATION OR AIR HUMIDIFYING EQUIPMENT

From the standpoint of proper utilization and care of wood products, air conditioning is an all-important factor. Every wood-working plant manufacturing high-class products should be properly equipped with apparatus to control temperatures, humidities and circulation. The moisture content which the wood has at the time of its manufacture should correspond approximately to the average it will eventually attain in use, or slightly less. The humidity of the air surrounding the article in use should, therefore, govern the extent to which the wood is dried.

Likewise, our stores, office buildings, public buildings, and homes should be air conditioned in order that many of our valuable wood products (radios, pianos, furniture of all kinds, cabinets, paneling, etc.) do not deteriorate from improper care. The future of air conditioning for all types of buildings should receive favorable acceptance from the standpoint of better health and comfort to the human inhabitants and also the proper care and use of essential and expensive wood products.

A Brief Review of Pipe Standardization

Prior to 1920, when the *American Society of Mechanical Engineers* suggested to the *American Standards Association* that a joint committee on the standardization of pipe flanges and fittings be organized, a small amount of standardization in this field had been completed by a joint committee of the manufacturers, the *Heating and Piping Contractors National Association,* and the *A. S. M. E.* This consisted of the following: (a) cast-iron flange and fitting dimensions for 125 lb. working pressure, (b) cast-iron flange and fitting dimensions for 250 lb. working pressure, (c) cast-iron flanges and fitting dimensions for 800 lb. hydraulic pressure, (d) cast-iron flanges and fitting dimensions for 1,200 lb. hydraulic pressure, and (e) cast-iron flanges and fitting dimensions for 3,000 lb. hydraulic pressure. The members of the Society realized the need for a thorough review of these standards, and recommended the designation of the "Manufacturers Standardization Society of the Valve and Fittings Industry," and the *H. P. C. N. A.* as joint sponsors with the *A. S. M. E.* for this project under the *A. S. A.*

This project was approved in June, 1920, and subsequently a large sectional committee now numbering fifty-five specialists, representing twenty-eight interested societies and trade associations, was formed. At its first meeting, the committee subdivided itself into subcommittee No. 1 on Cast-Iron Flanges and Flanged Fittings, subcommittee No. 2 on Screwed Fittings, subcommittee No. 3 on Steel Flanges and Flanged Fittings, and subcommittee No. 4 on Materials and Stresses.

Contrary to the original expectation, subcommittee No. 3 on Steel Flanges and Flanged Fittings was the first to organize itself to get into full swing. This activity was prompted by pressure from the industry. At that time there were no recognized standards for steel flanges and flanged fittings. Certain new central power stations had been designed and erected in which steel flanges and fittings had been used, based on the old cast-iron flange dimension. The 125 lb. flange patterns cast in steel, with additional bolts, was being used for 175 lb. steam pressure with high super-heat, and the 250 lb. cast-iron flange patterns with additional bolts were used for 350 lb. steam pressure with super-heat. There were also a few stations especially designed for 600 lb. steam pressure.

This subcommittee pursued its task vigorously, and, after holding a number of open meetings and conferences, it decided to set up a series of standards for steel flanges and flanged fittings for steam service at 250, 400, 600, 900 and 1,350 lb. steam pressure and 750 F. The cast-iron flange dimensions, with slight changes, were accepted for the first two standards in this series, but the 600, 900, and 1,350 lb. standards were based entirely on theoretical considerations, experience, and certain minimum strengths of materials.

This is one good illustration of a case where a standard has been created in advance of the art. As is well known, most dimensional standardization consists in reaching compromises between dimensions which are already established to a more or less extent in one way or another. The American Standards on Steel Flanges and Flanged Fittings were finally approved and published in June, 1927. It was not, however, until February, 1928, that the revised Standards for Cast-Iron Flanges and Flanged Fittings designed for 125 and 250 lb. per sq. in. steam pressure were finally approved and published.

Subcommittee No. 2 on Screwed Fittings also had a clear field. Up to the time of its organization, there had been individual manufacturer's standards but no group standards or American Standards. Its work progressed steadily from the beginning, and in December, 1927, the Standards for Cast-Iron Screwed Fittings for 125 and 250 lb. were completed, approved and published. The Standards for Malleable Iron Screwed Fittings were completed, approved and published in the same month and year. Sixteen months later, in April, 1929, the committee completed and published the revised Standards on Cast-Iron Long Turn Sprinkler Fittings which had been originally developed by a committee of the *National Fire Protection Association.* This standard covers both flanged and screwed fittings.

The publication of these several standards and their application in the art have prompted the organization of three new subcommittees—namely, subcommittee No. 5 on Face to Face Dimensions of Ferrous Flanged Valves, subcommittee No. 6 on Malleable Iron or Steel Brass Seat Unions, subcommittee No. 7 on the Rating of Pipe Fittings, and subcommittee No. 8 on the Marking of Pipe Fittings.

Any and all of the above standards as they may be completed are issued under the auspices of the *American Standards Association,* "which serves as the national clearing house for engineering and industrial standardization, acts as the official channel of cooperation in international standardization, and provides an information service on engineering and industrial standardization matters. The ultimate responsibility for and control of the work rests with the forty national organizations whose representatives constitute the Standards Council."

Standardization on National Scale

"The *A. S. A.* approval of a given standard means that a national consensus has been reached. It is, therefore, the agency through which industrial standardization in this country is passing from standardization by associations, societies, and governmental agencies, to standardization on a national scale. Through its method and procedure, which are the result of extensive study and discussion on the part of the numerous bodies concerned, and which have been further developed through years of experience, the standardization work of the many bodies concerned is being broadened and unified into a system for creating national industrial standards."

"Open for Discussion"

A department in which we follow the custom of technical societies in allotting space in their programs for discussion of the papers presented

Humidifying Cotton Mills

"Proper Placing of Humidifier Controls in Cotton Mill Card Rooms Important," *by James W. Cox Jr.* Page 932, November, 1930, issue.

MR. COX'S article in your November issue on the subject of humidification in the card rooms of cotton mills raises a number of points that are worthy of further discussion.

The various unfavorable conditions described by Mr. Cox as commonly found are attributable to a variety of causes, among which may be mentioned insufficient provision of humidifying capacity, faulty location of humidifying units, poor distribution of moisture from units, and inadequate or faulty provision for control of humidity. The effects of such causes are not unusually complicated and magnified by poor supervision.

A card room requires much less evaporative capacity per unit of mill content than spinning or weaving. As compared with the latter, a card room, therefore, will be the better served by a relatively large number of small humidifying units to facilitate uniform distribution of moisture, the writer believes.

Humidity Regulators

Humidity regulators should be sufficient in number and so located as to limit variations in humidity throughout the department as a whole to a "commercially good" basis of performance.

Excessive ventilation and sharply localized drafts due to open transoms or doors—especially when connecting with the picker rooms—are bound to cause trouble unless avoided by intelligent supervision.

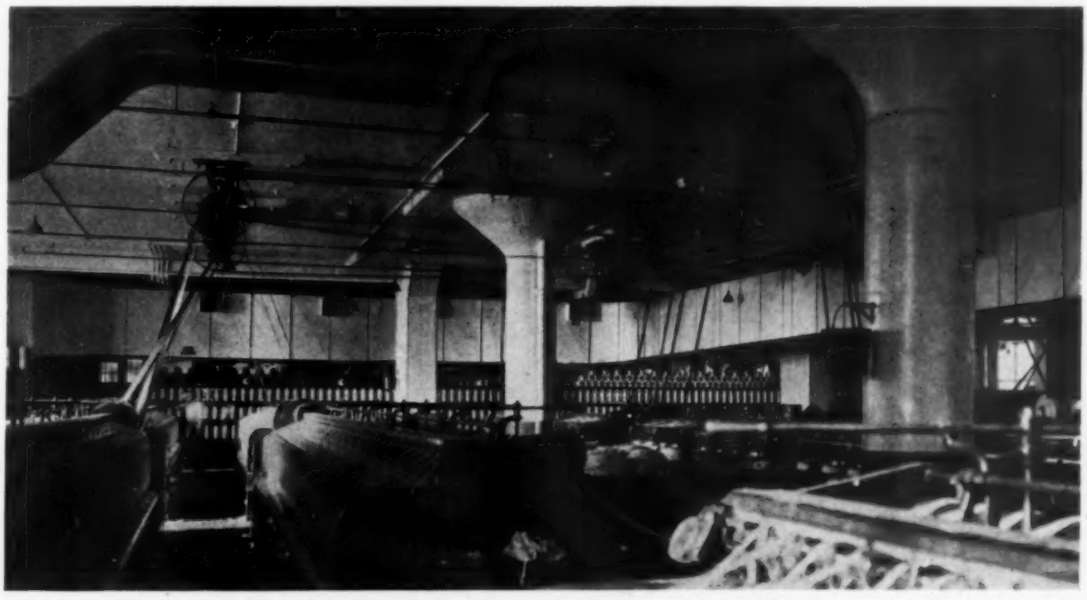
While the vertical stratification described by Mr. Cox is always likely to exist in some degree, it should not be difficult to maintain the desired humidity in the "working plane" when reliable regulators are used in adequate number and in suitable locations. Such differential in humidity as there may be between the regulator plane and the working plane is easily corrected by proper regulator adjustment, which should always aim at the production of proper conditions in the working plane rather than at the regulator itself.

Lap Variation

Having made all such provisions for commercially uniform humidity in the working plane, good processing and reasonably uniform moisture content in the finished sliver should be attainable. Uniform weight of sliver, however, and processing also, would still be unfavorably affected to a certain extent by lap variation—which is another story altogether and a major consideration.

The first and most important characteristic to be aimed at in the lap turned off by the finisher picker is uniformity in the dry weight, that is, uniformity in the actual bulk of staple present in a unit length of lap regardless of variation in moisture content or regain.

The importance of this subject has had wide recognition in the most progressive mills, many of whom are now practicing correction of actual lap weight. This is attained by frequent observation of the finisher lap weight in the picker room and by corrective adjustment, applied as changes in the humidity of the picker room



HUMIDIFYING THE ROVING DEPARTMENT OF A COTTON MILL

are observed, to the end that the actual weight of the finished lap shall so correspond to the humidity then existing in the picker room that its dry weight shall be maintained constant despite variations in moisture content.

As humidity rises in the picker room and moisture content of the cotton increases, the actual weight of the lap should be correspondingly increased above the normal standard, and conversely, as humidity falls and moisture content decreases, the actual weight of the lap should be correspondingly decreased to compensate for decreasing moisture content.

The adoption of this practice involves the use of correction tables indicating the proper actual weight of the lap to correspond to a given humidity observed. Special dials attachable to the dial of the weighing scale are quite commonly prepared, reading in terms of humidity, and may be conveniently and properly used for this same purpose.

Will Show Improvement in Uniformity

This practice is not as complex as it appears and its use under proper supervision has been followed by marked improvement in the uniformity of sliver, roving and yarn weight and count throughout the mill. Coupled with properly stabilized humidity throughout the manufacturing departments, it leads to the elimination of gear change and draft correction throughout the mill to the irreducible minimum.

Humidified Picker Rooms

Stabilized moisture content in the picker lap is still another story. The practice of correcting lap weights as above described is generally held to be of greater importance, but many mills, in addition to adopting this practice, have also humidified their picker rooms.

In a humidified picker room it is general practice to aim at a relative humidity of about 55 per cent, which can be maintained easily with moderate humidifying capacity and proper regulation throughout that greater portion of the year when moderate humidities prevail.

There are, however, many days in a normal summer, especially in certain parts of the South, when hot, humid weather will cause regulators in the picker rooms to cut the humidifiers out altogether for long periods while humidities higher than 55 per cent prevail. During such periods the management, even in humidified picker rooms, should rely upon correction of lap weight as above described.

Humidification of picker rooms can hardly be said to return the same dividends in terms of increased production as in other departments, but those who practice it appear to be satisfied that the outlay is worth while because of the reduced lap variation that follows.

While proper humidifying practice in the card room contributes to improvement in all subsequent stages of manufacture, it should be supplemented by a picker room practice that cures the evils of variation in the dry weight of the lap.

As an adjunct to card room humidification, the importance of sound practice in the picker room can hardly be too heavily stressed, and I am glad of this opportunity to supplement Mr. Cox's comments on this subject.—*A. W. Thompson.*

Sizing Pressure Regulators

"Pressure Reducing Valves," *by Sabin Crocker.* Page 20, January 1930 issue.

THE writer has read (somewhat tardily) the interesting article by Mr. Crocker on pressure reducing valves in the January issue, as well as the succeeding discussion in the May issue on the sizing of reducing valves.

It seems to him that a fundamental factor has been neglected in this discussion: that is, the maximum admissible variations of the reduced pressure.

The writer presented at the fourth Heating and Ventilating congress, held in Brussels, June, 1930, a paper entitled "The Automatic Regulation of Temperatures and Presures" in which is developed a graphic study of what seems to him the only rational method for sizing pressure regulators. The following is an abstract from the principles involved.

Variations in the Reduced Pressure

There are no pressure regulators which are able to maintain an absolutely constant reduced pressure; there is always some variation, the amount of which is essentially dependent upon the following factors:

1) The extreme values of initial pressure and steam flow.

The lowest value of the reduced pressure will be practically found with minimum initial pressure and maximum flow; inversely, the highest value of the reduced pressure will correspond to maximum initial pressure and minimum flow.

2) The sensitivity of the type of regulator considered with regard to variations of the reduced pressure.

In most types of commercial reducing valves, to each value of the reduced pressure, corresponds, at equilibrium, a different position of the valve; and inversely, to each lift of the valve corresponds a different value of the reduced pressure. This may be seen readily by analyzing the functioning of reducing valves, such as the ones described by Mr. Crocker in his article.

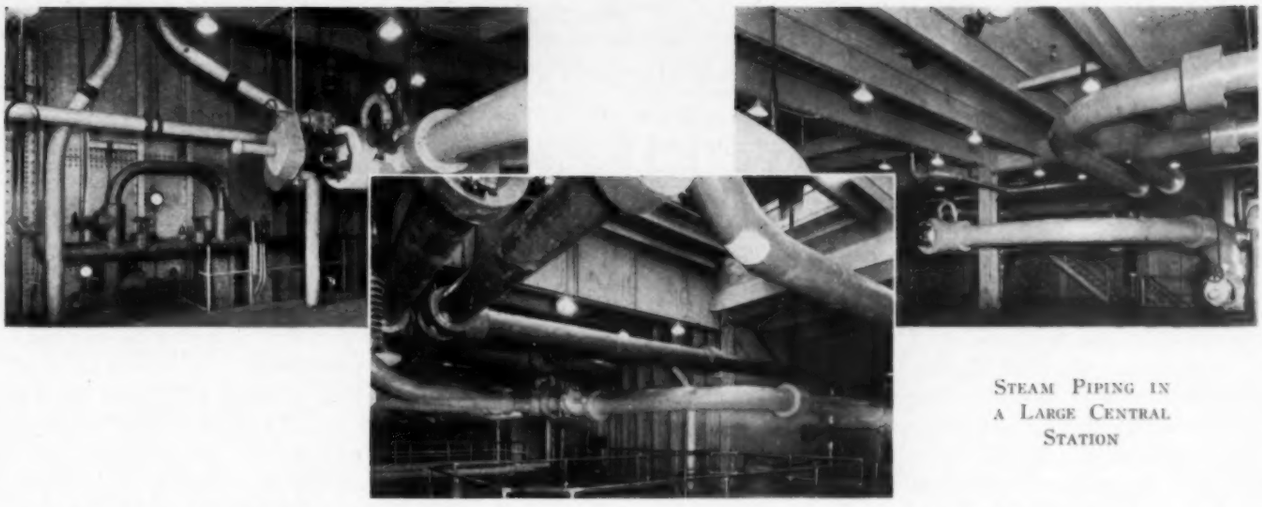
The sensitivity of a regulator can be measured by the variation of the valve's lift for a given variation of the reduced pressure.

3) The friction between the moving and fixed parts of the regulator.

The influence of this factor may be reduced to a minimum by the manufacturer, thanks to a careful construction and to an adequate dimensioning of the motor (diaphragm, piston, etc.) of the valve.

4) The **size** of reducing valve chosen for a given job. This is a factor which has very often been disregarded; yet, its influence gives the key to the sizing of reducing valves.

From the maximum steam flow to be carried through the valve and from the minimum initial pressure a minimum size of valve may be derived by means of Napier's formula, as explained by Mr. Crocker, but larger sizes of valves may



STEAM PIPING IN A LARGE CENTRAL STATION

also be used, and the question arises as to what size is to be recommended.

The Valve Lift

Let us consider a regulator of given make and size; for a given variation of the reduced pressure, whatever the values of the initial and reduced pressures and of the valve's lift may be, the variation of the valve's lift will always be the same. Now, this variation will have the *more* influence, when the lift itself, or the flow through the valve, is *smaller*.

Hence, the regulation of the reduced pressure will be the more exact when the maximum flow to be carried through the valve is smaller. And inversely, *the closer the regulation desired for a given service, the larger the size of the regulator.*

Wire-Drawing

There is, however, a practical limitation to this rule; when a regulator of too large a size is chosen, the lift of the valve is so small that the cutting action of wire-drawing becomes unavoidable; moreover, the smallest parts of scale which would stick between valve and seat could make the regulation ineffective.

From the aforesaid, it may be seen that the rational sizing of a reducing valve, while not at all a very difficult problem, requires the knowledge of some characteristics of the valves, such as sensitivity and friction, which generally are not available in the catalogs of the manufacturers.

Information Necessary About the Valve

Hence, it is advisable to question the manufacturer about the size of the valve to choose in each case; the inquiry must state these four questions:

The maximum and minimum values of steam flow.
The maximum and minimum values of initial pressure.
The minimum desired value of the reduced pressure.
The maximum admissible variation of this pressure.

Admissible Variation

There is still a point which is worth mentioning. The study of pressure regulators shows that, for a given size and make, the variation of the reduced pressure is substantially independent of the mean value of this pressure. Now, the admissible variation is generally proportionate to the reduced pressure; for instance, a variation of 50 lb. per sq. in. may be suffered with a reduced pressure of 300 lb. per sq. in., while not more than 1 lb. will be tolerated with a reduced pressure of 5 lb.

From this it follows that, for a given make, the size of a reducing valve should generally be the larger when the reduced pressure is lower. This conclusion must of course be somewhat modified when the valves for low reduced pressures are manufactured with special diaphragms or pistons.—*H. Marcq,* Chief Engineer, Heating and Ventilating Department, Compagnie Belge des Freins Westinghouse, Brussels, Belgium.

Mr. Crocker Replies

The discussion contributed by H. Marcq introduces an interesting phase of reducing valve performance regarding which little has been published. Purchasers of reducing valves are prone to assume that the reduced pressure at the valve outlet is constant, which is not true as pointed out by Mr. Marcq. Perhaps some of the readers of this discussion will have some data on this; its publication would be of value.

The characteristic of maximum pressure under a shut-off condition and minimum pressure at a maximum flow condition is exhibited by other automatic devices such as temperature controls, governors and the like. In fact it would seem that this characteristic is inherent to any type of modulating device, and in some cases may be compensated for by change in adjustment of the spring or other control device from time to time to suit flow conditions. Where rapid fluctuations in flow exist, this is impracticable, of course, and the automatic device must be counted on to keep conditions within acceptable bounds.

A rational attempt to select the size regulator which will maintain close adjustment and at the same time avoid excessive wire-drawing is a step in the right direction, and more information along this line is to be desired. It would be most interesting if manufacturers and users of reducing valves and similar automatic control equipment would publish data as to actual results obtained in service at different rates of flow for a variety of valve sizes and operating conditions. This information would serve as a basis for determining what results are reasonable to expect in existing or projected installations.—*Sabin Crocker.*

Condensate Used in Hotel

"Condensate from Heating System Used as Hot Water Supply for Building," *by R. M. McQuitty*. Page 762, September, 1930, issue

I READ with great interest the article in the September issue of HEATING, PIPING AND AIR CONDITIONING by R. M. McQuitty, and thought that you would like to know of one of the first installations for the use of condensate installed twenty years ago in the Hotel Pontchartrain, Detroit, on a large scale and worked successfully until the building was torn down. This was designed by the writer and has been installed in several buildings since then. All these jobs worked out well, saved considerable money, and furnished pure, soft water.

The installation saved all the condensate, which was taken from the overflow of the meters and pumped through a filter, thence to the various parts of the building where it was used, and the overflow was used in the laundry. All the circulating ice water lines were supplied, all drinking water served on the tables in the dining room and restaurant used it, and from twenty to twenty-five tons of ice per day were made from it. It was also used to supply the hot water heaters which made a saving of steam used, and the water bill was reduced. The soap bill for the laundry was lowered due to the water's softness.

All the water lines were brass. Water used for laundry purposes or drinking should be filtered as frequently there is a lot of moulding sand that constantly keeps coming down, especially at the start of the heating season.—*Edward Y. Dow.*

The Author's Reply

In my article entitled "Condensate from Heating System used as Hot Water Supply for Building," the formula appearing on page 765 should read as follows:—

Steam required per month for water heating if condensate of steam is utilized $= \frac{W-C}{K+1}$ M. lbs.

I am very much interested in Mr. Dow's comments, especially since they bear out the fact that condensate is pure water and suitable for building use. I am sure there must be quite a few such installations for making use of condensate, a description of which would prove very interesting.

Condensate for Making Ice

As to using condensate for purposes other than hot water, one hotel in St. Louis uses condensate for making ice. There are many other industrial requirements for distilled water for which condensate could be utilized.

A large department store in St. Louis has been using condensate as hot water supply for the last three years. The hot water thus supplied is used in the restaurant for cooking as well as in the beauty shop.

Filters

We have not needed filters, since with the design of the system we are using, the condensate float tank acts as a settling basin for any heavy solids such as flakes of rust or core sand. There is a small filter installed in the inlet of the pump which I have inspected once since the installation and found it to be practically clear of foreign matter. I can easily see how filters might be required on some installations, however.

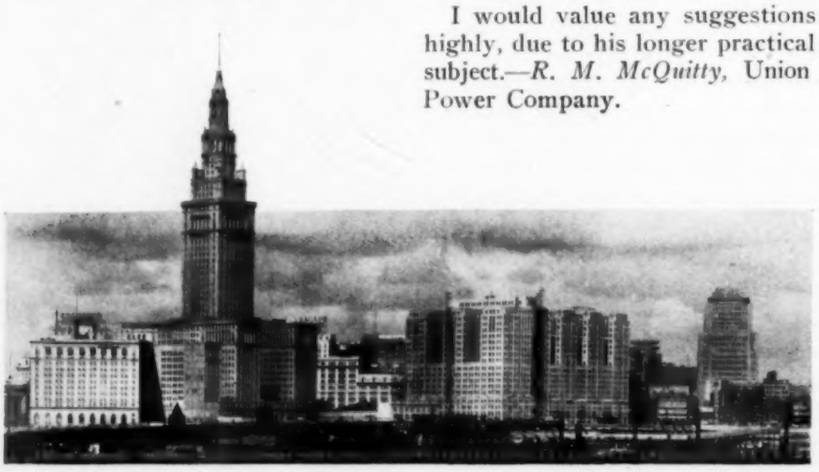
Testing for Corrosion

As to corrosion in hot water piping, any tendency for corrosion should show up in the returns on the heating systems. While this is possible, it is something that can be determined by analysis or observation before the condensate is utilized.

Evidently, in the design as mentioned by Mr. Dow, no city water was mixed with the condensate as is done in the design as described by the writer. In checking up on corrosion, a test section of pipe was removed for inspection and the coating was found to be still intact and had no signs of corrosion. Another test section was weighed when the system was installed and weighed again after six months and no signs of pitting could be found in this manner.

The only signs of rusty water we have noticed have been when the steam is first turned on the system. It is necessary to drain the condensate to the sewer for approximately one hour until it clears up.

I would value any suggestions of Mr. Dow very highly, due to his longer practical experience on this subject.—*R. M. McQuitty,* Union Electric Light and Power Company.



Heating·Piping
and Air Conditioning

American Society of Heating and Ventilating Engineers
JOURNAL SECTION

DECEMBER 1930

Material in this Section prepared by Publication Committee: G. L. Larson, *Chairman;* H. H. Angus, and W. A. Rowe : A. V. Hutchinson, Manager of Publications

Table of Contents

Air Conditioning for Railway Passenger Cars, by A. H. Candee 1037
Air Leakage Through Various Forms of Building Construction, by F. C. Houghten, Carl Gutberlet and C. A. Herbert 1044
Noise and Ventilation, by G. T. Stanton 1049
An Automatic System of Hot Water Heating and Hot Water Supply, by Erwin L. Weber 1053
Detroit-Windsor Tunnel Opened 1057
Pittsburgh Prepares Pleasing Program, Jan. 26-29 1059
Nominations for Officers of the Society for 1931 1061
The Council Nominates Members for Committee on Research 1062
Of Interest to Members 1064
Local Chapter Reports 1067
Candidates for Membership 1069
Candidates Elected 1070

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Air Conditioning for Railway Passenger Cars

By A. H. Candee[1], East Pittsburgh, Pa.
NON-MEMBER

AIR CONDITIONING for railway passenger cars presents intriguing possibilities to the heating and ventilating engineer as well as to the refrigerating engineer. While the needs of this field have been known for some time, it was not until 1929 that a commercial solution of the problem was undertaken. At this time the Baltimore and Ohio Railroad applied to one of their standard coaches means for cleaning and circulating the air within the coach, which also included a mechanical refrigeration system for cooling the air. The success of this trial installation led to the application of a modified and improved system to one of their colonial-type diners. This diner,[2] the Martha Washington, was placed in regular service in April, 1930, and was the first practical and commercial installation of its kind in the world. It was not actually the first air-cooled car in the world, however, for it has been the practice to cool cars in Egypt and India by hanging wet cloths or matting over windows and on the roofs to reduce the temperature within the cars by the evaporation of the water.

The operation of the Baltimore and Ohio car has been an outstanding success, and has attracted widespread interest among the railroads. The Santa Fe quickly followed with a similar dining car,[3] and other railroads will undoubtedly apply these principles in the near future. One railroad has also instituted the practice of precooling passenger cars of some of its crack trains in hot weather by placing ice on a special truck and drawing air over this ice through the cars before the passengers are admitted. The details of the Baltimore and Ohio and Santa Fe installations are shown in Figs. 1 to 14.

It is recognized that the air cooling and conditioning of most of the railway passenger equipment is inevitable, once it has been shown to be practicable. Those who have had occasion to travel on the railroads in the summer time or who have entered a sleeping car which has been occupied for some time will appreciate the comfort of clean, fresh air at the right temperature. The railroads also recognize the importance of this as a means of attracting the traveling public, which is showing a marked tendency to travel by automobile, bus, or airplane rather than by rail.

Extent of Air Conditioning Field for Railway Cars

There are approximately 65,000 railroad cars in passenger service in the United States, of which approximately 9,000 are Pullmans. The percentage of that number which may be considered as suitable for air conditioning is unknown, but a survey shows that there are approximately 165 named trains in operation which could be equipped advantageously with air conditioning apparatus. A conservative estimate of the number of passenger cars required to fill out these trains daily and protect the service is 5,500 cars. It is also estimated that there are at least 5,500 cars operating in other first class trains scattered throughout the country, upon which air conditioning apparatus may be installed advantageously. This would then indicate the potential field for air conditioning to be at least 11,000 cars,

FIG. 1—PIONEER AIR CONDITIONING INSTALLATION IN A COACH OF THE BALTIMORE AND OHIO RAILROAD

and probably more nearly 15,000 cars if equipment is developed having low first cost and low operating expense.

The two air-conditioned cars in operation at present are in the nature of trial installations. They are demonstrating the feasibility of applying refrigerating plants to railway cars for cooling purposes, but the heating systems of the cars have been unchanged. The ultimate equipment will undoubtedly have the

[1] Railway Engineer, Westinghouse Electric and Manufacturing Company.
[2] Railway Age, August 9, 1930.
[3] Railway Age, August 23, 1930.

heating system modified at the time refrigerating equipment is applied, so that the temperature of a car may be controlled at all times by the addition of heat to, or the extraction of heat from, the circulated ventilating air.

FIG. 2—BALTIMORE AND OHIO DINER

Air conditioning may be divided into three general phases:

1. Supply and circulation of cleaned fresh air.
2. Control of temperature of the air.
3. Humidity control.

For the immediate future, it is doubtful whether there will be any attempt to control closely the humidity of the air within a car because of the complications involved and the lack of space for equipment and water supply. The band of comfort to passengers is so broad that it is entirely feasible to adjust the air temperature to maintain comfortable conditions. Thus, in the winter time, a passenger will feel just as comfortable at a relative humidity of 10 per cent and an air temperature of 72 F as at a relative humidity of 50 per cent and an air temperature of 68 F. This means that while thermostatic temperature control will be used normally, it is advisable for the train crew to have some manual adjustment of all controlled temperatures within the cars of the train, to compensate for variations in atmospheric humidity. Such thermostatic control must permit of practically constant temperature during cold weather, but must allow of a rising interior car temperature as the exterior temperature rises, for the spread between the two should seldom exceed 15 deg (dry-bulb), or the effect on passengers is likely to be unpleasant. The preferable differentials in temperature with average external humidity are shown by Table 1.

Basis of Air Conditioning Railway Cars

One of the greatest advantages of any system of air conditioning is the provision of clean fresh air for the passengers. The opening of passenger car windows is usually accompanied by a swirl of cinders, soot, and smoke, yet at present one cannot travel in the summer time without having them open. The basis of air conditioning must, therefore, be to have all windows closed and locked, and to draw the ventilating air through a cleaning device of some sort which will exclude the dirt and dust, after which it must be properly circulated within the car to provide equal distribution without excessive drafts. Sealed double-sash windows, improved insulation, and elimination of ventilators and bracket fans will no doubt be features of the air-conditioned car. This will also make a quieter car, as external noises will be more effectually excluded.

It is not possible to locate an air intake in a railway car where clean air from the outside is insured. It is, therefore, necessary to remove the cinders, dust and dirt by artificial means, such as an air washer or a dry type of filter. While the former has the advantage of being a cooling medium and a means of controlling the humidity, the space required is a serious handicap in a great many cars. The dry type of filter will probably be used, if an air washer cannot be applied, and may even be used in series with the air washer to remove the larger particles from the air stream. Any dry type unit must be located for easy removal for cleaning purposes. It appears that the cleanest air may be obtained high in the car, near the roof. The two existing installations previously mentioned draw in air through the vertical walls of the clearstory just above the half deck of the car, where deck ventilators are normally placed.

TABLE 1—PREFERRED INTERIOR TEMPERATURE REGULATION
(*Exterior Temperatures above 70 F*)

External Temp. F	Interior		
	Dry-Bulb Temp. F	Wet-Bulb Temp. F	Effective Temp. F
95	80	65.2	73.4
90	78	64.5	72.2
85	76.5	64.0	71.1
80	75	63.5	70.2
75	73.5	63.0	69.3
70	72	62.5	68.2

FIG. 3—INTERIOR VIEW OF BALTIMORE AND OHIO DINER SHOWING AIR OUTLETS UNDER THE HALF-DECK

Amount of Air Required

The amount of air circulated per minute per passenger in a railway car equipped with air conditioning apparatus will vary somewhat with the particular type of car. It is clearly necessary

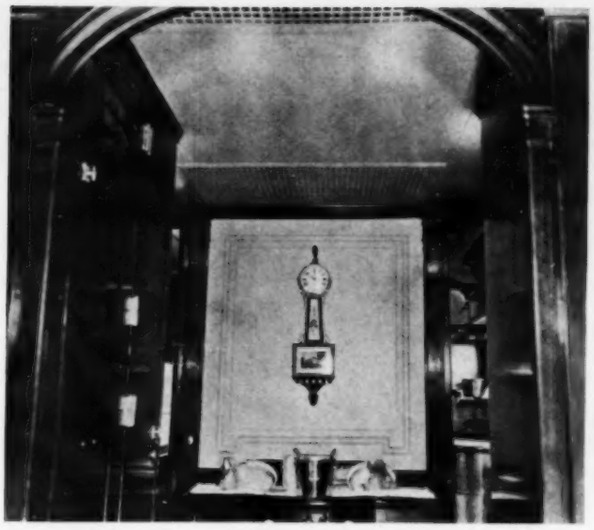


FIG. 4—CEILING LOUVRES FOR AIR RECIRCULATION IN THE BALTIMORE AND OHIO DINER

to recirculate a portion of the air in order to reduce plant capacity required for heating or cooling purposes where limited power and space are available, and the amount of fresh air drawn from the exterior of the car will vary with atmospheric conditions and with the application. It is obvious that a dining car must have more fresh air supplied (on account of pollution due to kitchen smoke and odors) than a parlor car, and that a smoker must have considerable fresh air in order to clarify the interior atmosphere. This indicates the desirability of selective variation in the ratio of incoming fresh air to circulated air. While railway ventilation practice in the past has generally been based on 15 cu ft of air per minute per passenger, it is expected that forced circulation and careful distribution of the air will

TABLE 2—APPROXIMATE DATA FOR PASSENGER COMPARTMENTS

	Length Compartment (Feet)	Floor Area (Sq. Ft.)	Interior Volume (Cu. Ft.)	Maximum Seating Capacity	Volume per Passenger (Cu. Ft.)
Coach	58	522	4060	100	40
Sleeper	37½	337	2740	48	57
Parlor Car	46	414	3360	26	130
Diner	39	350	2850	36	80
Smoking Room	10	65	540	6	90
Drawing Room	7	43	380	5	76

reduce this figure somewhat. Table 2 is submitted as a guide in determining required air circulation for different passenger compartments. On the basis of 15 cu ft per minute per passenger, it would be necessary to change the air in a coach every 3 minutes, in a sleeper every 4 minutes, in a parlor car every 9 minutes, and in a diner every 5 minutes as a maximum. However, since air movement assists in improving the comfort of a cooled car, it is desirable to circulate the air at a faster rate than this in the summer time, reducing the fan speed and delivery for cold weather conditions.

From the foregoing discussion, it will be apparent that the essentials of the air circulating system include one or more air filters equipped with manually-operated shutters which may be adjusted at will, or completely closed in passing through tunnels, a circulating fan (preferably of variable manual speed control), and a suitable duct system for proper distribution of the air throughout the car and for recirculation of a portion of that air. The amount of air allowed to escape from the interior must be equal to that introduced, and with a sealed car will mean the provision of a variable vent.

Location of Heating and Cooling Units

With an air circulating system provided on a car, the best temperature control may be effected by placing both the heating and the cooling units directly in the ventilating air stream, preferably close to the fan, adding or subtracting heat as required. The location of the heating coils in this way will improve the efficiency of heat transfer and save in cost and weight over the present system of extending steam pipes along the sides of a car near the floor. The fact that it may be necessary to circulate both the heated and the cooled air through the car in the same direction will probably be unimportant in the face of practical considerations.

Steam, generated at the locomotive, has long been the source of heat for maintaining comfortable temperatures within a train in cold weather, although this inflicts a severe handicap on motive power with low ambient temperatures. An ordinary coach having a 70-ft passenger compartment requires nearly 100 hp from the locomotive for heating under the maximum conditions in zero weather, which means that approximately half as much energy is used for heating as for train propulsion under these conditions. It is undesirable to draw power from the locomotive for auxiliary purposes if it can be avoided in any way, but the use of steam for heating cannot easily be discarded.

Methods of Cooling

For the cooling of cars in hot weather, means must be arranged for passing the ventilating air over a cold body in order to extract heat. There are three general systems available for providing such a cold body:

1. A material having heat-absorbing characteristics, such as ice.
2. An absorption system of mechanical refrigeration.
3. A compressor system of mechanical refrigeration.

Differentiation between the absorption system and the compressor system has been made on account of the fact that the one employs heat direct, while the other requires mechanical energy. In considering their application to railway cars, this may be of considerable importance.

Any refrigerating method should be carefully considered from a practical standpoint, weighing the relative

FIG. 5—COMPRESSOR BOX OF THE BALTIMORE AND OHIO DINER

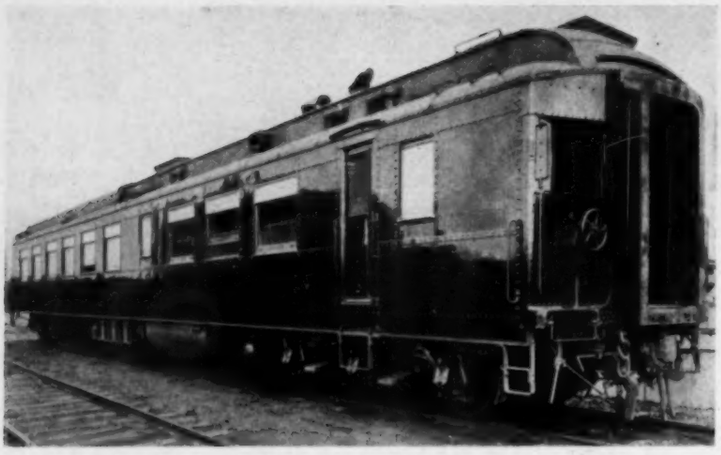


FIG. 6—SIDE VIEW (KITCHEN END) OF THE SANTA FE DINER

effects of practicability, reliability, weight, first cost, and operating expense. It may be used a maximum of 50 days a year, yet it must ride with the car for the other 315. The air circulating system, however, is used the year round.

The refrigerating system must be safe, above all else, allowing no escape of fumes within the car and no danger of explosion even in case of accident to the car. The weight, first cost, and operating expense are economic factors and must be justified on the basis of an increase in revenue, for the railroads cannot continue to provide additional comforts for the traveling public unless these comforts show returns in increased passenger traffic or unless the fare per passenger is increased.

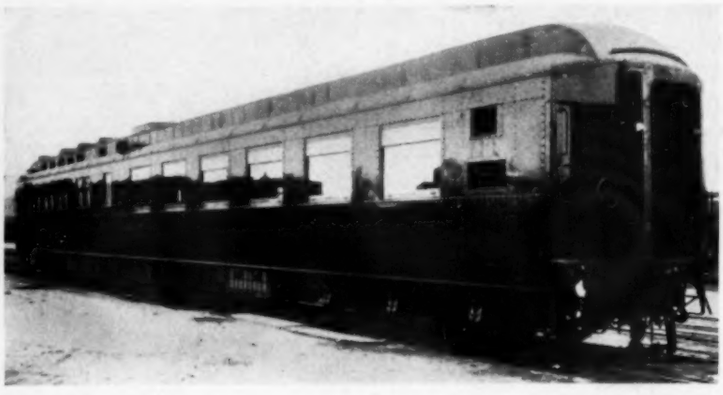


FIG. 7—VIEW OF THE COMPRESSOR SIDE OF THE SANTA FE DINER

The most common method of providing heat absorption capacity is by the use of ice. It is estimated that from one to two tons of ice will keep a car cool for at least a day under the most severe conditions if the melting is properly controlled. Such a method of refrigeration, however, requires daily recharging of the ice boxes, but compared with mechanical refrigeration, the apparatus carried on the car is simple.

Absorption systems are available for maintaining low temperatures in refrigerator cars, but the development has not yet progressed to a point where they may be applied to the air conditioning of passenger cars. The fact that heat is used in place of mechanical energy offers very attractive possibilities, as the fuel may be carried on the car itself, and may be replenished with little difficulty. It is expected that new developments in this field will be announced shortly, which will simplify the application of refrigerating systems to railway cars.

It is logical that the first air-conditioned cars should employ mechanical refrigeration, as this field has had the advantage of considerable development. The question of power supply, however, is troublesome and together with the refrigerating mechanism adds considerable to the weight and cost of a car.

There are six general methods of providing the energy required for a mechanical refrigerating system (excluding the absorption system):

1. Steam power plant on each car.
2. Steam power plant on or near the locomotive.
3. Internal combustion engine power plant on each car.
4. Internal combustion engine power plant on the locomotive or in a baggage car.
5. Axle driven generator on each car.
6. Axle driven generator on each car supplemented by a storage battery.

It will be noted that in methods (1), (2), (5) and (6) the energy is obtained by subtraction from the motive power, except in cases where steam may be generated in a separate boiler such as is used in connection with an electric locomotive. Method (3) renders a car independent of movement or connected motive power. With method (5) energy is supplied only when the train is in motion and it is to overcome this handicap that method (6) was devised. The Baltimore and Ohio diner employed method (5), and the Santa Fe, method (6), but alterations in the former have been made so that the cooling water pump and the ventilating fans now operate from the battery and thus continue the cooling while the car is standing for short periods. Schemes such as (2) and (4) require that electric power circuits be carried the length of the train. While such a distribution system cannot be applied in

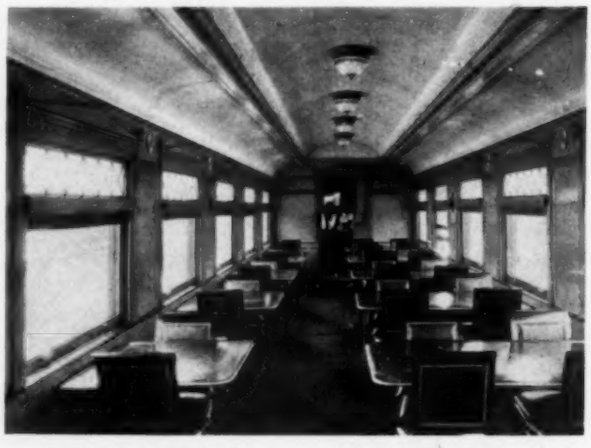


FIG. 8—DINING COMPARTMENT OF THE SANTA FE DINER. NOTE THAT AIR OUTLETS ARE INCONSPICUOUS

the immediate future, due to the fact that it is an immense task to apply such conductors to the number of cars involved, it is obvious that the electrical comforts and conveniences such as are found in a great many homes will ultimately be available to the railroad traveler and that this will require a dependable power system. Some of the most prominent railway electrical engineers forecast the use of such power generation and distribution on trains, with the consequent elimination of the troublesome axle-driven generators and storage batteries now in use.

For the immediate future, therefore, it may be assumed that there are several practical methods of obtaining a cold body, namely, ice carried in an insulated compartment and melted as required; absorption systems of refrigeration using a stored liquid, gaseous or solid fuel supply which may be replenished at will; a steam or internal-combustion engine-driven mechanical refrigerating plant; or equipment using an axle generator as the means of utilizing motion of the car for transmitting energy from the locomotive. Although the two diners now in operation utilize axle generators, it is doubtful whether this practice will continue.

Calculations indicate that from 60,000 to 80,000 Btu per hour maximum must be absorbed in order to provide effective cooling of a diner or a sleeping car. Experience has shown that this requires an input of from 10 to 13 hp to a refrigerating plant of the mechanical type. The heat to be extracted is calculated as shown by Table 3, making due allowance for improvements in insulation of the car. Any mechanical system of cooling must have a capacity equal to the short time demand such as is indicated in Table 3, but the total capacity of any system using heat absorbing material, such as ice, may be based on an integration of the demands throughout the complete run of the car between recharging stations.

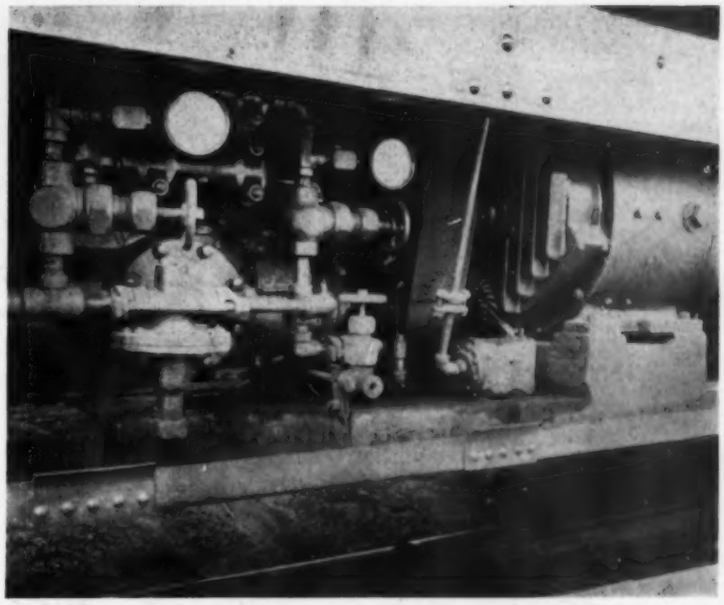


FIG. 10—MOTOR DRIVEN AMMONIA COMPRESSOR WITH FITTINGS OF THE SANTA FE DINER

TABLE 3—CALCULATION OF HEAT EXTRACTION FOR A SLEEPING CAR*

	BTU PER HOUR
Heat through car walls	11,000
Solar radiation	10,000
Heat from make-up air	30,000
Passenger radiation [300 Btu per hour per passenger (48 passenger maximum)]	14,400
Power of blower	1,500
Loss in pipe lines	2,000
Total	68,900

* Based on following conditions: External temperature, 95 F; internal temperature, 80 F; time, 2:00 to 4:00 P. M.; average train speed, 30 mph; maximum conditions.

Description of B. & O. Diner Installation

In the installation of the air-conditioning equipment in the diner of the Baltimore and Ohio Railroad, the cooling coil of a mechanical refrigerating plant is located in a compartment above the passage way from the dining room to the pantry and kitchen. This consists of finned pipes carrying cooled water. Air is drawn from the outside of the car through two filters, one being mounted on each side of the car above the half-deck, and is passed through the cooler on its way to the electrically-driven circulating fans. The air is carried along the two sides of the roof of the car in ducts, as may be observed in Fig. 2, and enters the dining room through louvres distributed the length of the compartment, visible in Fig. 3. The discharge of air to compensate for that entering is effected through the kitchen exhaust fans and other doors which may be open. Two horizontal louvres in the bottom of the cooling compartment, shown by Fig. 4, permit of air recirculation and temperature control. One or the other of these is always open, either passing the recirculated air through the cooling coil or by-passing it to maintain

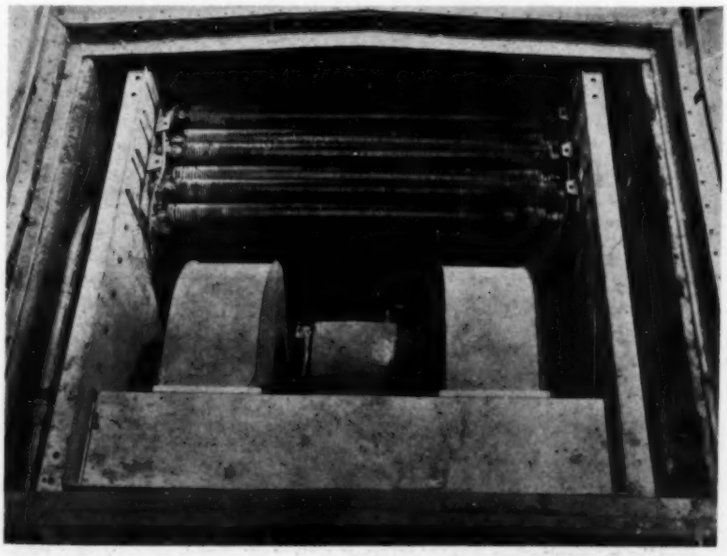


FIG. 9—AIR COOLING UNIT AND CIRCULATING FANS OF THE SANTA FE DINER

temperatures. A thermostat governs the operation of the shutters over these louvres.

An ammonia refrigerating system is mounted under the car floor, a motor-driven compressor, a condenser, an expansion valve, and an evaporator comprising the main equipment. The ammonia is cooled and condensed

FIG. 11—SPRAY TOWER FOR COOLING CONDENSING WATER OF THE SANTA FE DINER

through the medium of water, which in turn is cooled in a spray tank occupying a space formerly used for a locker at one end of the car above the floor. Water is also used in the air cooler, this water being maintained at 40 to 50 F by passing through coils in the evaporator tank.

Circulation of water between the condenser and the spray tank and also between the evaporator tank and the air-cooling unit is by means of motor-driven centrifugal pumps. As previously stated, an axle-driven generator supplies the power for the compressor motor, the air-circulating fan, the motor in the spray tank, and the two water-circulating pumps. This generator, which is entirely separate from the axle generator which charges the storage battery and furnishes energy for lighting, normally develops 115 volts at a car speed of 28 mph and above, so that until the car reaches this speed, no energy is available for operation of the refrigerating system. The *cutout* voltage is approximately 80 as the train speed descends.

Description of Santa Fe Diner

The Santa Fe diner is similar in most respects to the Baltimore and Ohio diner. One of the differences is in the detail of air ducts and openings into the dining room, which may be noted by a comparison of the exterior and interior views. Another difference, of major importance, is that all of the power used for refrigerating, air circulation, lights and other purposes is generated by two axle generators at 32 volts (nominal) and a large storage battery is used in conjunction with these generators so that power is available for operation of the cooling system whether the car is in motion or standing. The fact that the Santa Fe trains may experience extreme changes in temperature within a single day in passing from the deserts to the mountains makes a third difference necessary. The condenser and evaporator tanks are located on the roof along the side of the clearstory so that with the refrigerating system shut down, all water drains back inside of the car. These tanks may be observed in the side view of the car, Fig. 6.

The drive mechanism of an axle generator has always been troublesome, and storage-battery maintenance is a considerable factor in operation. The combination is essential if continuous power is to be provided from an axle-generator system. It appears to be more desirable to use a small internal combustion engine power plant on each car if vibration, noise and fumes may be rendered unnoticeable within the car. Individual steam power plants are probably not practical on account of the diffi-

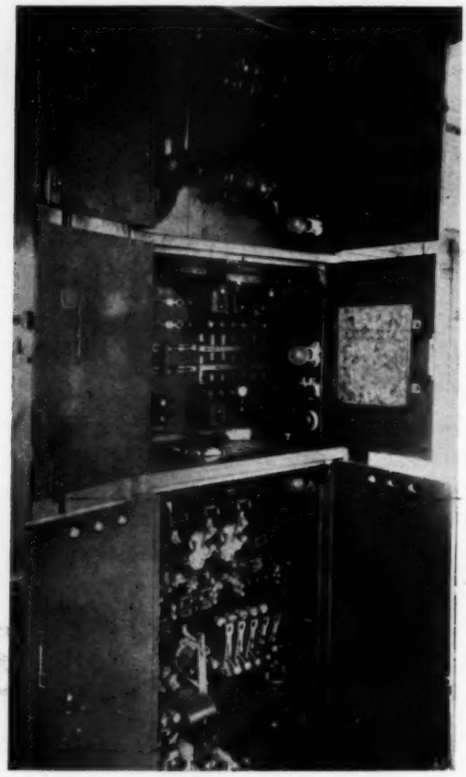


FIG. 12—CONTROL CABINET OF THE SANTA FE DINER

culty of supplying steam at reasonably constant pressure in the summer time when a car is in a yard or station without connected motive power.

Problems to Be Solved

There are a great many problems to be solved. Who is now able to forecast the best method of refrigerating, of arranging units, of supplying energy, and of insulat-

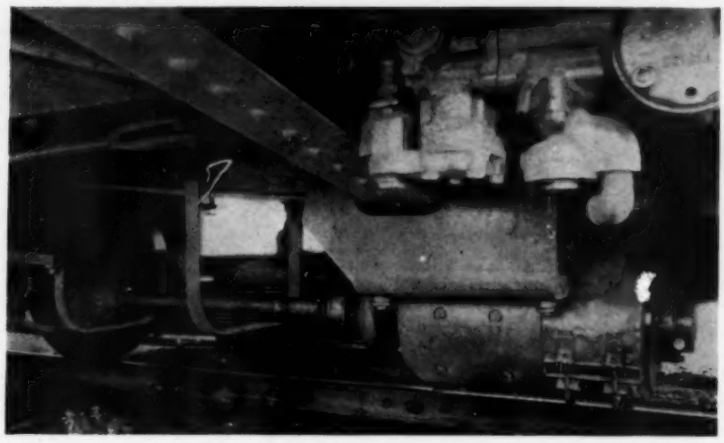
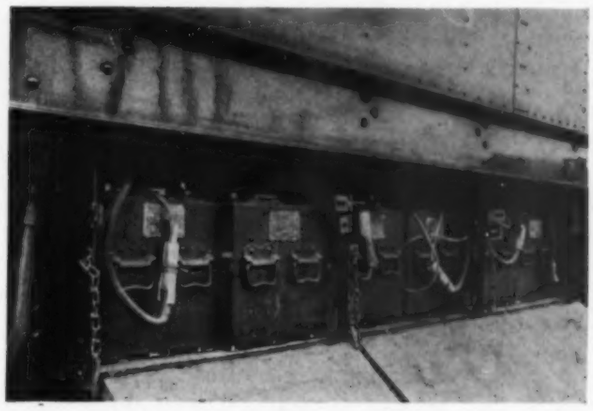


FIG. 13—ONE OF THE 7½-KW AXLE-DRIVEN GENERATORS OF THE SANTA FE DINER

justified. It is one thing to apply such a system to a car, but it is an entirely different matter to train an organization, scattered over the country, in operation and maintenance so that the equipment will function continuously and efficiently. The problem is not alone that of the railroads, but involves the heating, ventilating and refrigerating engineers of the country, by whose efforts simple and reliable equipment can be developed. Preference will be given to those systems which employ the minimum number of working parts, the lowest operating expense, and the minimum of space requirements.

FIG. 14—(BELOW) A PART OF THE 2250 AMP-HR STORAGE BATTERY OF THE SANTA FE DINER



ings cars? These questions can be answered only by experience, and trial installations such as have been made have already advanced the available knowledge considerably. It is highly probable that the resulting research will materially reduce the amount of steam used for heating, through the use of double windows fastened in place and carefully sealed, through different materials and methods of blanketing the car, and by better heat transmission from the steam pipes to the air. This factor alone, if accomplished, will represent a considerable saving to the railroads.

Many railroads are interested in air conditioning, but few feel that the weight, cost, and complication of the present types of mechanical refrigerating units can be

A. G. A. Issues Book on Water Heating

The sixth volume of the Industrial Gas Series of the *American Gas Association,* entitled Water Heating has recently been issued. This volume was prepared under the supervision of the Committee on Large Volume Water Heating of the Industrial Gas Section, by C. G. Segeler, Editor.

The contents of this book include: Economics of Water Heating, Water Heating Systems, The Hot Water Requirements, Gas Water Heating Equipment, Efficiency of Water Heating, Water Heater Accessories, Domestic Water Heating, and Selling the Water Heater.

The attention of the gas industry is now turning to the large volume water heating business as a most desirable load, particularly for the summer time, as it will help to offset the increasingly severe winter peaks resulting from the growth of house heating. Several optional methods for estimating the amount of hot water required on a maximum day, have been suggested in this book. The selection of the proper size equipment to best fill these needs is based on experience extending over many years, and represents a practice which will assure good hot water service to the customer without making the first cost unduly high through the purchase of oversize equipment.

This book is a valuable contribution to the gas industry.

High Volatile Bituminous Coal

The simplification of sizes and terminology of high volatile bituminous coal handled over the docks at the American head of the Great Lakes is covered in Miscellaneous Publication No. 113 of the U. S. Bureau of Standards, which has recently been issued. Copies of this publication may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

The question of uniform terminology and sizing of high volatile bituminous coal has been considered by various groups for several years. Owing to the wide variation in local conditions, no large group in any branch of the industry had succeeded in reaching an agreement on this subject. Diversity in terminology and size slowly but steadily increased, particularly during the 15 years immediately preceding the adoption of this recommendation. The effect of this diversity has been serious.

In 1928, representatives of coal dock operators on the Great Lakes took up this problem with the Department of Commerce. After some correspondence, and conferences among representatives of the dock operators, the *American Society for Testing Materials,* the Bureau of Mines, and the Division of Simplified Practice of the Department of Commerce, this recommendation was adopted.

Air Leakage Through Various Forms of Building Construction

By F. C. Houghten,[a] (*MEMBER*) Carl Gutberlet,[b] (*NON-MEMBER*) and C. A. Herbert,[c] (*NON-MEMBER*) Pittsburgh, Pa.

THE study of infiltration through masonry walls was undertaken at the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS in 1925. The tests were made in two pieces of apparatus (Fig. 1) designed for that purpose. Early in the investigation it was discovered that the rate of infiltration through masonry walls increased for several months after building, and as a result, the testing of different types of construction in the available apparatus in the Pittsburgh Laboratory became a very slow process.

In 1927 the major portion of the infiltration studies of the Laboratory was transferred to the University of Wisconsin under a cooperative agreement. Profiting by the earlier experience in Pittsburgh, the apparatus at Wisconsin was so designed that a large number of walls could be built in steel frames which could later be moved into the testing machine from time to time as the walls aged. This made possible a more rapid testing program, since the testing apparatus was not tied up by a single wall during the aging process.

Since 1926, the two pieces of apparatus at the Laboratory have been kept in constant use with the result that there has now accumulated data on several types of construction which are made the basis of this report. These data will help in extending the knowledge of the infiltration through different types of construction and will also serve to indicate variations which may be found in the rate of air leakage through different walls of the same type built by different mechanics under different conditions.

All of the walls tested at the Laboratory since 1926 and here reported were built by Prof. C. W. Larkin, Head Instructor of Masonry at Carnegie Institute of Technology. In building these walls an attempt was made to follow as nearly as possible the practice of the building industry.

The method of conducting the tests was identical with that previously used and reported in detail in earlier Laboratory reports[1,2]. The wall to be tested was built as a partition between the pressure chamber and the collecting chamber of the test apparatus (see Fig. 1). Except in cases where edge losses were the subject of investigation, the joint between the apparatus and the wall was carefully sealed with calking compound and then painted with an asphalt base paint so as to limit the leakage measured to that through the 6x10 ft. section of wall under test.

The desired wind pressures were produced in the pressure chamber by means of a blower and the air leaking through the wall into the collecting chamber was measured as it passed out through the calibrated orifice. A Wahlen gage was used to measure the pressure drop through the orifice and a sensitive inclined gage was used to measure the pressure drop through the wall. In analyzing the data, the leakage per square foot of wall or per linear foot of crack was plotted against pressure drop through the wall and the equivalent wind velocity.

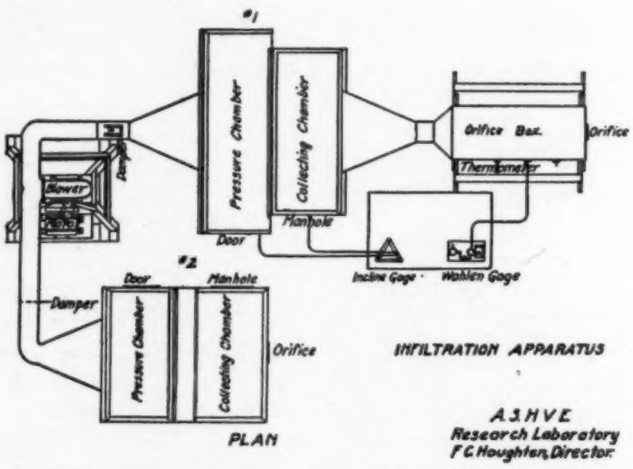


FIG. 1—ARRANGEMENT OF APPARATUS FOR MEASURING LEAKAGE OF AIR THROUGH WALLS

Data are given in this paper on the following types of construction:

1. A 13-in. brick wall after plaster had been removed from the wall and the joints repointed.
2. Same as (1) with the application of paint.
3. A frame wall consisting of siding, sheathing, paper, lath and lime plaster.
4. Same as (3) with gypsum plaster.
5. Same as (4) with sizing and paper.
6. Leakage per foot of crack between plaster or stucco and wood frame.
7. A stucco wall consisting of sheathing, paper, metal lath, and stucco (without inside plaster finish).
8. A 13-in. brick veneer hollow tile wall.

Figs. 2, 4, 7 and 8, and Table 1 indicate the infiltration rates found for these types of construction.

Results of Tests

Brick Wall

The brick wall on which leakage values for both the

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[c] Research Assistant, Research Laboratory, AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
[1] *Air Leakage Through the Opening in Buildings*, by F. C. Houghten and C. C. Schrader, (A. S. H. V. E. TRANSACTIONS, Vol. 30, 1924).
[2] *Infiltration Through Plastered and Unplastered Brick Walls*, by F. C. Houghten and Margaret Ingels. (A. S. H. V. E. TRANSACTIONS, Vol. 33, 1927).

TABLE 1—RESULTS OF TESTS SHOWING AIR INFILTRATION IN CUBIC FEET PER HOUR PER SQUARE FOOT OF WALL SURFACE FOR VARIOUS WIND VELOCITIES

Fig. No.	Curve	Types Of Construction	Age in Days	Wind Velocity Miles Per Hour					
				5	10	15	20	25	30
2	A	13-in. plain brick wall	22	1.80	4.90	9.35	14.50	20.30	25.50
2	G	Same as 2A, with plaster on brick	183	0.006	0.016	0.031	0.054	0.084	0.121
2	B	Same as 2G, plaster removed, wall repointed	384	1.35	3.25	6.15	10.20	14.95	20.00
2	C	Same as 2B, with one coat paint	387	1.25	2.85	5.10	8.00	11.60	15.65
2	E	Same as 2B, with three coats paint	398	1.05	2.45	4.50	7.00	9.60	12.50
2	F	Same as 2B, with six coats paint	406	0.02	0.06	0.10	0.15	0.20	0.25
4	C	Frame wall siding, paper, sheathing, studs, lath and lime plaster	156	0.25	0.60	1.10	1.90	2.95	4.10
4	D	Frame wall siding, paper, sheathing, studs, lath and gypsum plaster	145	0.25	0.45	0.75	0.95	1.10	1.35
4	E	Same as 4D, with sizing and paper	266	0.10	0.22	0.42	0.60	0.75	0.95
7	B	½ in. sheathing, studding, paper, metal lath and stucco		0.12	0.25	0.40	0.50	0.70	0.90
7	D	13 in. brick and tile wall		1.05	2.90	5.55	8.60	12.15	16.15
				Infiltration in cfh per foot of crack					
8	H	Average, crack between frame and plaster or stucco		0.06	0.135	0.236	0.360	0.50	0.65

plastered and plain wall were reported in an earlier Laboratory report was tested after the plaster had been carefully removed and the joints had been repointed. The leakage is given in curve *B*, Fig. 2. This leakage is found to be somewhat lower than that reported for the same plain brick wall before plastering which leakage is shown in curve *A* for comparison. This reduction is probably due to better pointing of the joints after the plaster was removed. One coat of paint was then applied to the inside brick surface with the result shown in curve *C*. Curve *E* gives the results after the application of three coats of paint. It was rather astonishing to those conducting the tests that the paint did not have a greater effect in reducing the leakage, but upon careful inspection of the surface, it was found that the paint did not fill up and seal over the larger cracks and crevices in the wall and it was apparent that the greater portion of the leakage took place through these openings. The wall was then carefully examined and calking material placed in all visible cracks or crevices, followed by an application of paint. This was repeated three times, resulting in leakage indicated by curve *F*. It is apparent that careful calking and painting of brick walls will give a reduction in leakage comparable to the reduction found for plastering. Curve *G* indicates the leakage earlier reported for the plastered brick wall and is included for the sake of comparison. It should be emphasized, however, that this result was obtained only through a very laborious process of searching out all cracks and crevices and seeing that they were sealed up and covered with paint. It is doubtful if this is a practical procedure.

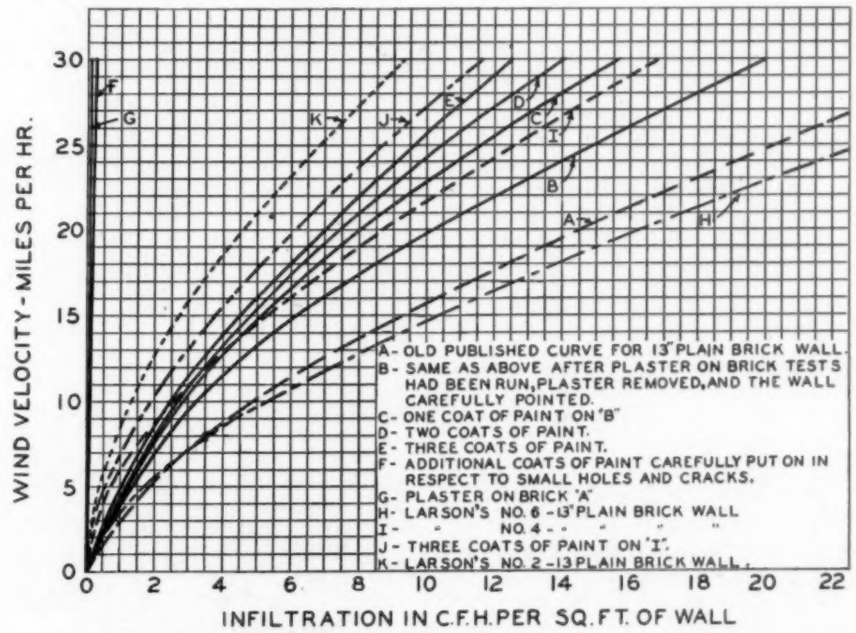
WIND VELOCITY - MILES PER HR.
INFILTRATION IN C.F.H. PER SQ.F.T. OF WALL
0
5
10
15
20
25
30
0
2
4
6
8
10
12
14
16
18
20
22
A- OLD PUBLISHED CURVE FOR 13" PLAIN BRICK WALL.
B- SAME AS ABOVE AFTER PLASTER ON BRICK TESTS HAD BEEN RUN, PLASTER REMOVED, AND THE WALL CAREFULLY POINTED.
C- ONE COAT OF PAINT ON "B"
D- TWO COATS OF PAINT.
E- THREE COATS OF PAINT.
F- ADDITIONAL COATS OF PAINT CAREFULLY PUT ON IN RESPECT TO SMALL HOLES AND CRACKS.
G- PLASTER ON BRICK "A"
H- LARSON'S NO. 6 -13" PLAIN BRICK WALL
I- " NO. 4 - " " "
J- THREE COATS OF PAINT ON "I".
K- LARSON'S NO. 2 -13 PLAIN BRICK WALL.

FIG. 2—INFILTRATION THROUGH 13-IN. BRICK WALLS

Curves *H*, *I* and *K*, resulting from tests by Larson and Nelson[3] are also included for purposes of compar-

[3] *Air Infiltration Through Various Types of Brick Wall Construction*, by G. L. Larson, D. W. Nelson and C. Braatz, A. S. H. V. E. [JOURNAL Section (Heating, Piping and Air Conditioning) November, 1929.]

ison. These are for 13-in. brick walls of the following types: *H*, poor workmanship, lime mortar and porous brick; *I*, good workmanship, cement lime mortar, and porous brick; *K*, good workmanship, cement lime mortar and hard brick. Curve *J* indicates the leakage reported for the *I* wall after the application of three coats of paint.

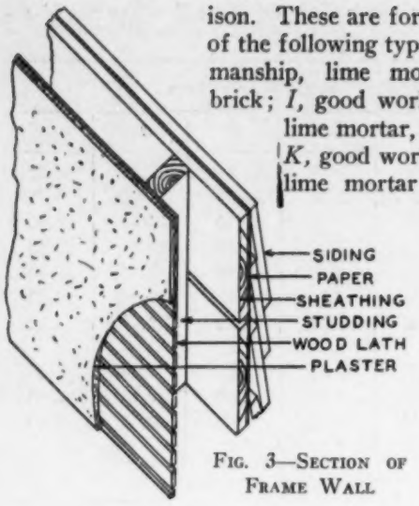

FIG. 3—SECTION OF FRAME WALL

Frame Wall

The details of construction of the frame wall are shown in Fig. 3. The outside construction consisted of ⅞ in x 8 in. sheathing, building paper, and lap-siding. The sheathing was purchased on the local market for this purpose and was applied immediately with the butt edges firmly against each other so as to allow no visible cracks. After removing the first coat of plaster several months later, it was observed that the sheathing had shrunk showing cracks from ⅛ to ¼ in. in width.

The interior of the wall was lathed and plastered with two coats of rough lime plaster and one lime skim coat. After aging, the frame wall with this plaster showed the leakage indicated by curve *A*, Fig. 4. However, a considerable portion of this leakage took place through the joint between the plaster and the surrounding wood frame as indicated by the infiltration shown by curve *C*, found after sealing the joint. Fig. 5 is a cross section of the construction showing this crack. The frame

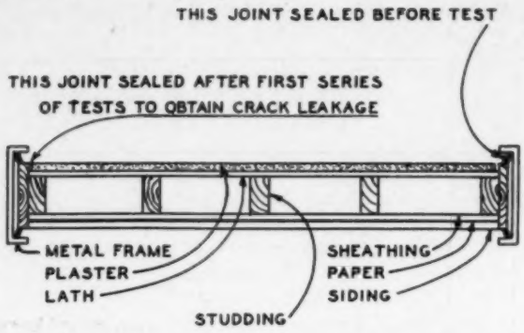

FIG. 5—CROSS-SECTION OF FRAME WALL SHOWING CRACKS

construction on which the lath and plaster was applied was built in a 1½ x 8-in. board frame placed in the channel iron frame forming part of the apparatus. The joint between the wood frame and the channel frame was carefully calked so that no leakage took place through this joint. The leakage through the frame wall

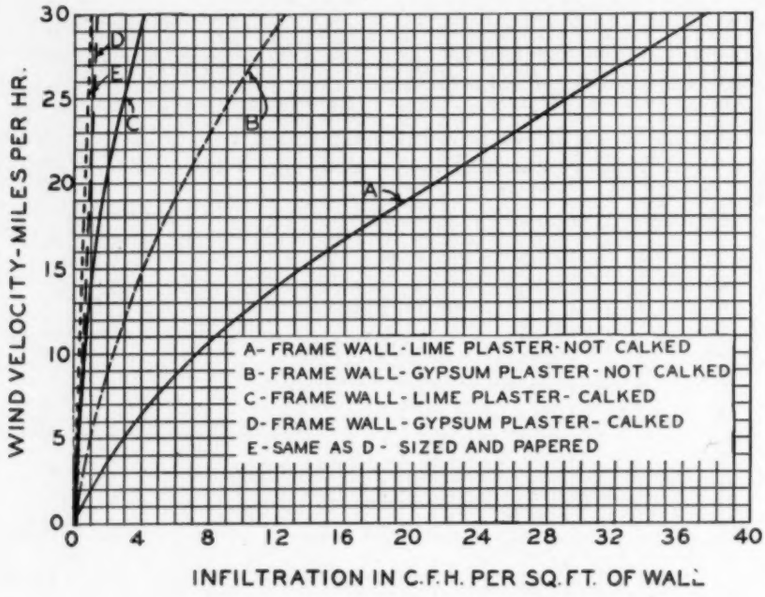

FIG. 4—INFILTRATION THROUGH FRAME WALLS

with gypsum plaster before sealing the crack between plaster and wood frame is given by curve *B* and that taking place after this crack was sealed is given by curve *D*. This wall was then sized and papered and again tested giving the leakage indicated by curve *E*.

Stucco Wall

The details of construction of the outside stucco finish is shown in Fig. 6. The ⅞ x 8 in. unmatched sheathing was

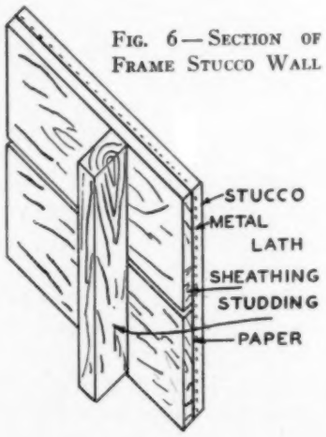

FIG. 6—SECTION OF FRAME STUCCO WALL

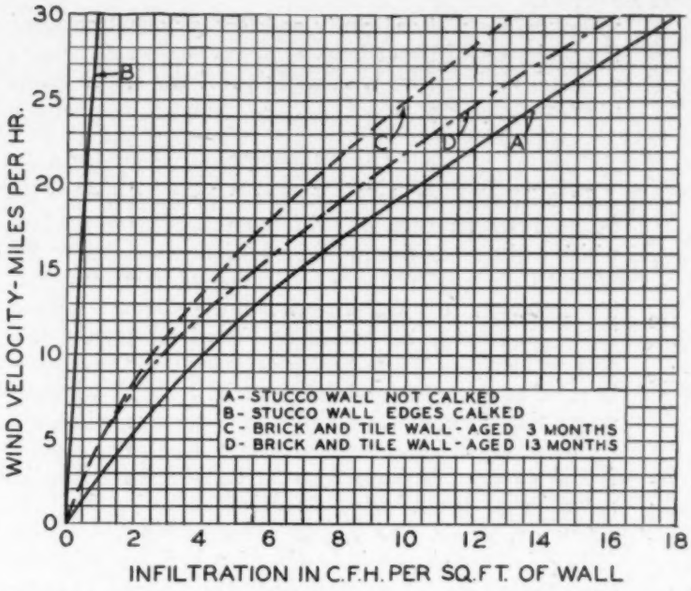
WIND VELOCITY-MILES PER HR.
INFILTRATION IN C.F.H. PER SQ.F.T. OF WALL
A- STUCCO WALL NOT CALKED
B- STUCCO WALL EDGES CALKED
C- BRICK AND TILE WALL-AGED 3 MONTHS
D- BRICK AND TILE WALL-AGED 13 MONTHS

FIG. 7—INFILTRATION THROUGH FRAME STUCCO, AND BRICK AND TILE WALLS

again purchased on the local market and immediately applied to the studding so as to give as small cracks as possible. Paper and metal netting was applied to the sheathing on which two coats of cement plaster and one coat of finish stucco were applied. By using special spacing nails the paper was held firmly against the sheathing and the wire netting was held about ¼ in. away which resulted in the netting becoming completely imbedded in the stucco. By the time the stucco had aged sufficiently for testing, it was again observed that the sheathing had shrunk so as to leave from ⅛ to ¼ in. cracks between boards.

The stucco wall was built in the same board frame discussed under the plastered wall and curve *A* (Fig. 7) gives the leakage after aging but before the crack between the stucco and the wood frame was sealed up while curve *B* gives the leakage for the same wall after this crack was sealed. Hence curve *B* represents the leakage per square foot of stucco wall.

Leakage Through Cracks Between Plaster and Wood Frames

The rates of leakage through the crack between the plaster and the wood frame in the two plastered walls, and between the stucco and the wood frame in the stucco wall, are given in the curves, Fig. 8. In closing this crack for the first plastered wall the top horizontal crack was sealed first giving the reduction per foot of crack indicated by curve *A*. Sealing the two vertical side cracks gave the reduction per foot of crack shown by curve *B* and sealing the bottom horizontal crack gave the reduction shown by curve *C*. The average reduction per foot of crack found by sealing the crack around the entire wall is given by curve *E*.

Sealing the crack around the second plastered wall gave the average reduction per foot of crack shown by curve *F* and sealing the entire crack around the stucco wall gave the reduction shown by curve *G*. Curve *D* gives the average leakage per foot of crack between plaster and wood frame or the average of curves *E* and *F*. Curve *H* gives the average leakage per foot of crack for the two plastered walls and the stucco wall or the average of curves *E*, *F* and *G*.

It is the opinion of the authors that the leakage shown by the curves obtained by the reduction of the leakage for the walls after sealing the joints is fairly representative of the leakage through the joint between plaster or stucco and the frame work of doors and windows and around the floor line of plastered walls. A very definite crack always appears at these points during the drying and aging process. It should be pointed out, however, that in most types of construction the finish trim is applied in such a way as to cover this crack. While such trim will always reduce the leakage through the crack to some extent, it rarely eliminates it entirely un-

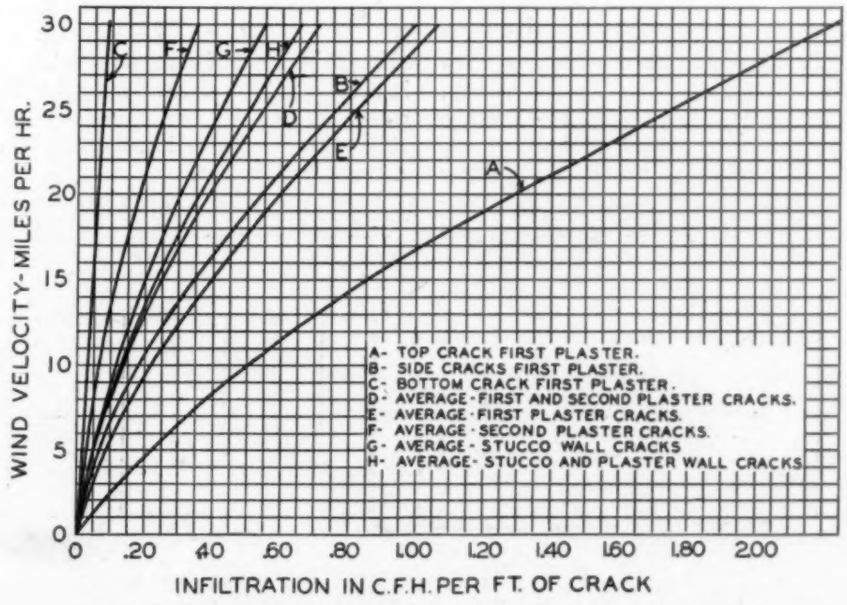
WIND VELOCITY-MILES PER HR.
INFILTRATION IN C.F.H. PER FT. OF CRACK
A- TOP CRACK FIRST PLASTER.
B- SIDE CRACKS FIRST PLASTER.
C- BOTTOM CRACK FIRST PLASTER.
D- AVERAGE-FIRST AND SECOND PLASTER CRACKS.
E- AVERAGE-FIRST PLASTER CRACKS.
F- AVERAGE-SECOND PLASTER CRACKS.
G- AVERAGE-STUCCO WALL CRACKS
H- AVERAGE-STUCCO AND PLASTER WALL CRACKS.

FIG. 8—INFILTRATION THROUGH CRACKS IN FRAME AND STUCCO WALLS

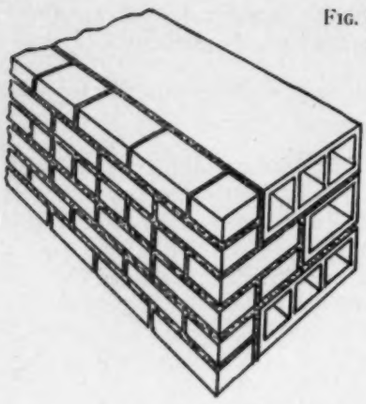

FIG. 9—SECTION OF BRICK AND TILE WALL

less special pains are taken to close the joint between the plaster and trim.

Brick Veneer Hollow Tile Wall

Details of construction of the brick veneer hollow tile wall are shown in Fig. 9. The joints between brick and tile were only partially filled with mortar in a manner similar to common practice. The leakage for this wall three months after construction is given in Fig. 7 by curve *C*, and the leakage after 13-months aging is given by curve *D*.

Heat Losses Due to Air Leakage

In tall single-story buildings, the *chimney effect* caused by the inside-outside temperature difference becomes a factor of importance. Even in multi-story buildings it usually is not possible to isolate the several floors completely, and chimney effect is operative to a considerable degree, tending to force air in at the lower levels and out at the upper. Ventilating systems usually are designed to give a neutral pressure in the rooms, and fan pressures therefore have little effect upon infiltration.

Since the full force of the wind usually is not the effective pressure differential, owing to back pressure built up within the building, the actual amount of infiltration (cubic feet) is assumed to be 80 per cent of that determined in laboratory experiments, which means that the pressure drop is assumed to be about 64 per cent of the full wind pressure.

Although all authorities do not agree upon the value of the wind velocity that should be chosen for any given locality for estimating the heat loss due to air leakage, it is common engineering practice to use the average wind velocity during the three coldest months of the year. The direction of prevailing winds may usually be included within an angle of about 90 deg. The windows that are to be figured for prevailing and non-prevailing winds will ordinarily each occupy about one-half the perimeter of the structure, the proportion varying to a considerable extent with the plan of the structure, as illustrated by Fig. 1.

Tall Buildings

In tall buildings, infiltration may be considerably influenced by temperature difference or chimney effect which will operate to produce a head that will add to the effect of the wind at lower levels and subtract from it at higher levels. On the other hand, the wind velocity at lower levels may be somewhat abated by surrounding obstructions. Furthermore, the chimney effect is reduced in multi-story buildings by the partial isolation of floors preventing free upward movement, so that wind and temperature difference may seldom co-operate to the fullest extent. Making the rough assumption that the *neutral zone* (see *Neutral Zone in Ventilating*, by J. E. Emswiler, A. S. H. V. E. TRANSACTIONS, Vol. 32, 1926), is located at mid-height of a building, and that the temperature difference is 70 F, the following formulae may be used to determine an equivalent wind velocity to be used in connection with infiltration tables that will allow for both wind velocity and temperature difference:

$$M_e = \sqrt{M^2 - 1.75\ a} \quad (1)$$

$$M_e = \sqrt{M^2 + 1.75\ b} \quad (2)$$

where

M_e = equivalent wind velocity to be used

M = wind velocity upon which infiltration would be determined if temperature difference were neglected

a = distance of windows under consideration from mid-height of building if *above* mid-height

b = distance if *below* mid-height

The coefficient *1.75* allows for about one-half the temperature difference head.

Example. If $M = 20$, the equivalent wind velocity at a height of 180 ft from the ground for a building 200 ft high would be

$$M_e = \sqrt{20^2 - 1.75 \times 80} = 16 \text{ mph}$$

For a window on the ground floor:

$$M_e = \sqrt{20^2 + 1.75 \times 100} = 24 \text{ mph}$$

For buildings of unusual height, Equation (1) would indicate negative infiltration at the highest stories, which condition may, at times, actually exist, although probably greater wind velocities should be figured at such extremely high levels.

For a further discussion of this subject, see A. S. H. V. E. GUIDE 1931.

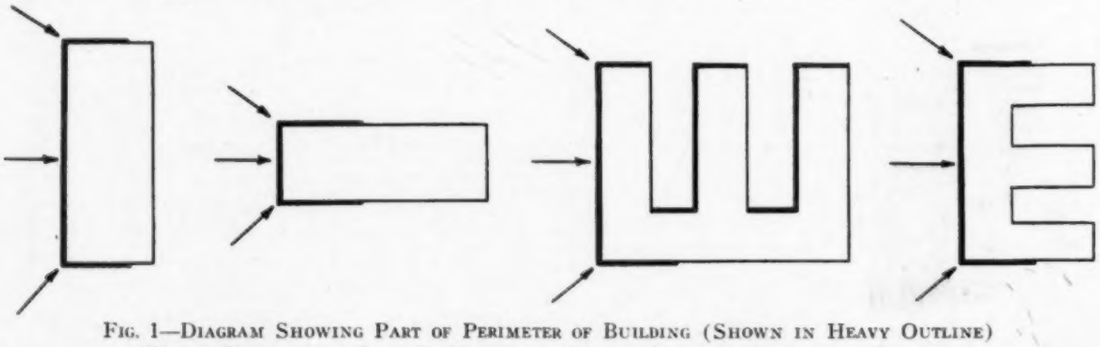

FIG. 1—DIAGRAM SHOWING PART OF PERIMETER OF BUILDING (SHOWN IN HEAVY OUTLINE) FOR WHICH INFILTRATION IS TO BE FIGURED AT HIGHER RATE ON ACCOUNT OF EXPOSURE TO PREVAILING WINDS

Noise and Ventilation

By G. T. Stanton[1], New York, N. Y.
NON-MEMBER

NOISE is variously defined, depending upon the viewpoint. The music from a radio, pleasant to the direct listener, is noise from the standpoint of a neighbor engaged in other pursuits. A popular definition, which seems adequately to express the usual conception, is that noise is any undesired sound.

The effects of noise on office employes has been studied extensively, and although it is difficult to evaluate the reduction of noise in terms of increased efficiency, greater output, higher quality or fewer errors, still the results, wherever tests have been carefully carried out, indicate that substantial dividends on the investment are possible. Noises, particularly when encountered during moments of relaxation, are detrimental in proportion to some psychological factor which may be termed their *annoyance*. Such annoyance is dependent upon many items and varies somewhat with each individual. For instance, to many people the monotonous repetition of a low intensity sound may create annoyance out of proportion to the loudness. However, the relationship between the annoyance of a sound and its pitch or frequency of vibration is rather definite. The annoyance or *stridency* of a sound is also associated with the degree to which its components lie in harmonic relationship to each other.

The architect and builder, to keep pace with modern demands, must, of necessity, consider the physiological aspect of his planning in order to avoid over-rapid obsolescence of the structures due to increased stringency of public standards for comfort and efficiency. In a building planned with these factors in mind, ventilation should, of course, be vital in making the structure suitable for continued efficient use, and in the future may be an ally of noise reduction. In metropolitan cities, the problem of noise is, to a large degree, that of overcoming the sounds from the street, from adjacent buildings and neighboring activities which stream through open windows. One solution of this problem is a ventilating system which, in addition to the many advantages obvious to ventilating engineers, affords the possibility of closing the windows and excluding the noise. However, when this advantageous factor in the employment of artificial ventilating and air-conditioning systems is considered, it is apparent that, above all, the ventilating system must not of itself create noise. Moreover, it must not act as a carrier of noise into the useful sections of the building.

The problem of reducing noise is broadly divided as follows:

1. Reduction of noise produced at the source.
2. Reduction of transmission of noise from the source to those areas under consideration.
3. Acoustic treatment in the area under consideration, to reduce the effect of the noise.

The problem as applied to ventilating systems appears to fall under items (1) and (2), namely, the reduction at the source and reduction in transmission. This also appears to be the most logical and satisfactory method in new construction. The architect, therefore, has an additional obligation imposed, that of securing in the finished building, conditions of quiet, suitable to the use of the property, judged by standards that are constantly increasing in severity. Hence, the noise problem is more and more frequently analyzed in the plan and specification stage.

The architect must have reasonably exact knowledge of the noise that will be created by such ventilating systems as may be installed, and include proper limits in the specifications. The performance of the system from a noise standpoint should be checked, for compliance, upon completion of the work. It would, therefore, seem desirable that more information be made available on this subject, that suitable measurements be made, and standards for allowable noise from different types of systems, be established.

Noise Measuring Instruments

There are available two general methods of noise measurement, namely, *audiometric* and *instrumental*, which may be subdivided as follows:

1. Audiometric
   a. Overall masking or deafening effect
   b. Frequency band masking or deafening effect
   c. Beat frequency analysis
2. Instrumental
   a. Overall noise level
   b. Noise level by frequency bands
   c. Frequency and noise level analysis

In the audiometric methods of measurement, dependence is made on the aural faculties along with some device which will permit the assignment of a numerical magnitude to the noise effect. In the buzzer audiometer, the tone from an electric buzzer connected to a telephone receiver is adjusted in intensity until it is judged to be as loud as the noise or until it is masked by the noise. In the latter case, the external noise and the buzzer noise are impressed by means of an offset receiver cap on the ear at the same time. The intensity of the test tone is varied by a calibrated attenuator until it can just barely be heard in the presence of noise. The difference of the reading obtained in the presence of the noise and that obtained in a very quiet place is a measure of the noise effect. In these and all threshold measurements the quantity measured is the deafening produced by the noise.

Methods utilizing the buzzer type audiometer give only the overall effect and give no indication of the quality or character of the noise. To obtain an indication of the noise quality, a variation of this audiometric

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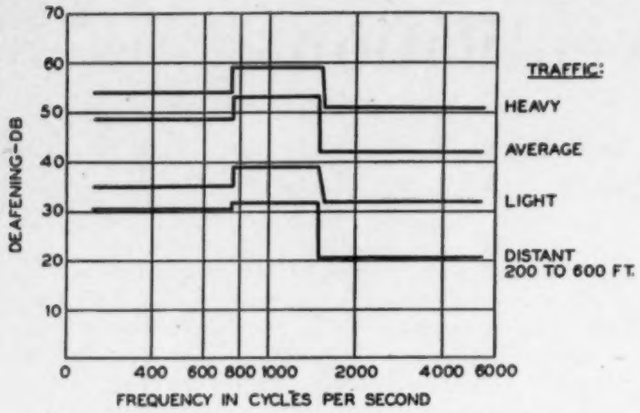

FIG. 1—AUDIOGRAMS OF OUTDOOR NOISE IN NEW YORK

method may be employed. In this case, the buzzer is replaced by equipment supplying either a series of constant frequency tones or warbling tones, each tone located in a different part of the frequency spectrum of audibility. The deafening effect of the noise is thus measured in each part of the sound spectrum and the noise audiogram can then be obtained. Fig. 1 indicates a typical warble frequency type of audiogram. Fig. 2 indicates a typical multiple tone type of audiogram.

In addition, by using a beat-frequency oscillator and audiometric methods, an approximate general analysis of the frequency spectrum of the noise can be obtained. In this case beats between the tone of the oscillator swung through the audible range and the noise created by the source can be obtained. This method will give an indication of the magnitude of the components and it will give a general idea of the location of the more prominent components in the audible spectrum. Considerable experience and ingenuity are necessary to obtain satisfactory results from this method.

In the instrumental methods, all observations are entirely independent of the ear and yield purely physical measurements of the noise level. For overall measurements, a type of instrument generally called a noise meter may be used, which gives a direct reading of the noise level. The meter consists of a sensitive microphone, a calibrated attenuator, a frequency-weighting network, and a rectifying device with a direct reading meter. The ear is most sensitive in the region of 2,000 cycles but requires a great increase in intensity or energy flow going toward high and low ends of the audible frequency spectrum to produce an effect of equivalent loudness. The frequency-weighting network is used to simulate the sensitivity of the human ear and thus obtain a measure of the loudness of the noise. Without this network the meter would indicate approximately the physical energy flow and would not indicate the physiological effect on hearing. The reading indicated by the noise meter is neither the true loudness level nor the true sensation units above the threshold of audibility but has arbitrarily been called the noise level. Experience has shown that the discrepancy caused by this assumption produces but a small error.

Since noise is a highly complex type of sound it is usually desirable to obtain information as to its character and quality. The use of band-pass filters in conjunction with the noise meter will give a measure of the quality and distribution of the energy components in the audible spectrum. The method consists of taking measurements of the intensity in selected frequency bands, such as 0 to 500 cycles, then 500 to 1,500 cycles, etc. Thus a somewhat more detailed picture of the character of the noise being measured can be obtained and a comparison of the level of the different frequency bands made. Fig. 3 indicates typical noise-meter measurements utilizing band-pass filters. Such information is valuable in the comparative study of noise created by different sources. Though two sources of noise might give the same overall noise level, one noise source could be more annoying than the other. Measurements made using band-pass frequency analysis would probably show them to differ in their composition. It has been proved by experience that aural judgment of quality cannot be depended on in these circumstances except in unusual and rare cases, due to the complexity of the frequency composition of normal noise sources.

For noise comparison, frequency band measurements are very satisfactory but for accurate analysis of the noise and its frequency components, it is necessary to decrease the width of the frequency bands. Harmonic analyzers have been devised to obtain automatically a frequency and level analysis of any sustained noise. This type of instrument takes rapid samplings of successive and very narrow frequency bands throughout the audible spectrum and records all readings. Such analyses give the complete history of the composition of the noise and allow easy segregation of the various factors contributing to the overall noise effect. Fig. 4 gives a typical harmonic analysis, showing the various components and their magnitude. Information of this nature is of considerable importance to the designer of mechanical and electrical equipment, for it makes it pos-

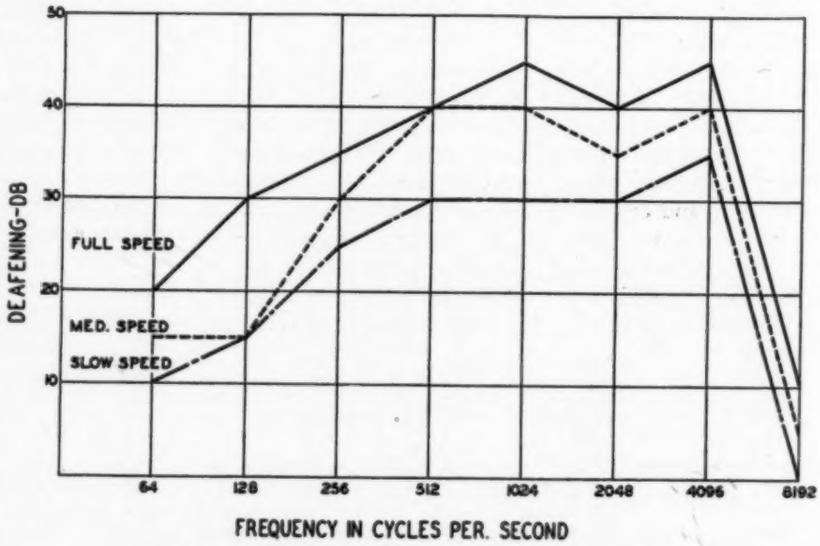

FIG. 2—AUDIOGRAM OF FAN AT VARIOUS SPEEDS

sible to locate every noise source and thus apply corrective measures. In addition, such an harmonic analysis can serve as an excellent means of checking the progress of efforts intended to reduce the noise conditions created.

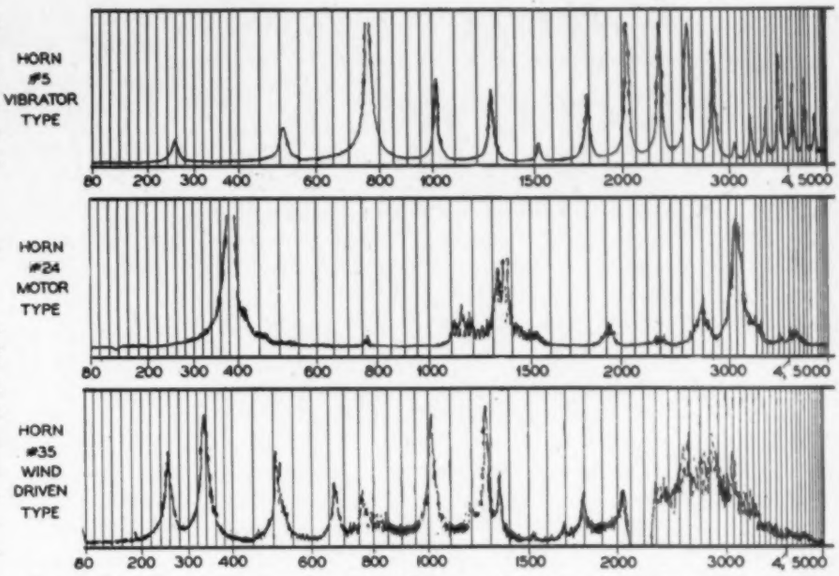

FIG. 4—TYPICAL HARMONIC ANALYSIS SHOWING VARIOUS COMPONENTS AND THEIR MAGNITUDE

Standardization of Noise Measurements

In the study of the noise problems involved in the operation of any given ventilating equipment, a routine procedure of testing must be set up that will allow correlation of test results with those involved in direct practice. This is particularly necessary in checking the compliance with specifications on minimum generation of noise. In addition, it is inherently essential that results can be duplicated consistently so that control checks of performance can be obtained. Furthermore, if the data on any given system under test are to be correlated with those obtained elsewhere on similar systems, the results must be reducible to a common basis.

It is not sufficient to make measurements of the respective noise levels. To have these measurements of value, the comparative conditions of tests must be taken into account. Control of the test conditions or means of calculating the equivalent acoustic conditions are required to obtain any comparative results. For example, consider a study of the noise created by a blower. Noise levels obtained with blowers set up on the test floor of the manufacturing shops will not be the same as measurements of noise levels obtained following the final installation of the blowers in their designated locations in theaters, office buildings, plants, etc. The difference of the conditions under which the tests are made are the controlling factors, provided it is assumed that the noise sources produce the same total acoustic energy output in the two cases.

There are numerous acoustic factors that can cause variation in the measurement of noise levels created by the same source in different locations. The variable factors primarily are as follows:

1. Cubic volume of rooms in which measurements are made
2. Total acoustic absorption present
3. The characteristic of the acoustic absorption over the audible spectrum
4. Presence of extraneous noise
5. Operating conditions of blower
6. Location at which measurement is made

The introduction of these variable factors would appear to make it impossible to secure comparative results. However, by a few simple assumptions it is possible to utilize the general acoustic theory quite satisfactorily. For a steady state condition,

$$E = \frac{4E'}{av} \tag{1}$$

where

E = the energy of the noise per unit volume
E' = the noise energy emitted by the source
a = the total acoustic absorption present
v = velocity of sound

It is of importance to note that all these units of noise energy are in physical units. For comparative purposes it is sufficient to assume that the noise energy emitted by the source will be a constant under all normal conditions. Then the relative factors for two different cases can be expressed as follows:

$$\frac{E_2}{E_1} = \frac{a_1}{a_2} \tag{2}$$

In other words, the energy density of noise will vary inversely as the acoustic absorption present. Equation (2) is based on the energy density of the noise in physical units. It is necessary to convert these values into units of noise level similar to those obtained by the instrumental means previously described. The simplest relation is as follows:

$$N_1 - N_2 = 10 \log_{10} \frac{E_1}{E_2} = 10 \log_{10} \frac{a_2}{a_1} \tag{3}$$

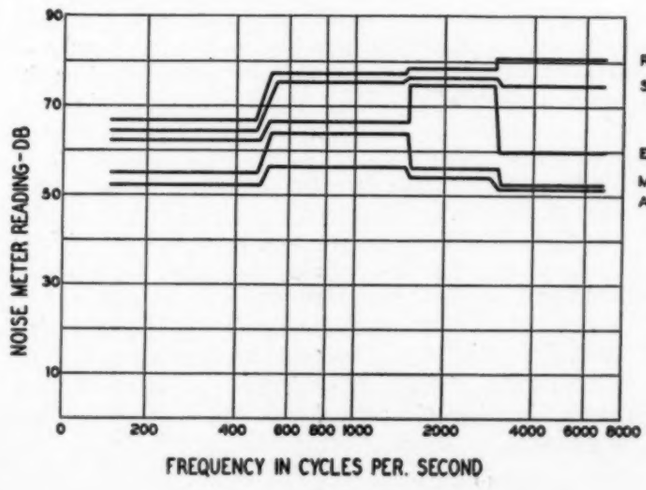

FIG. 3—PHYSICAL ANALYSIS OF VARIOUS NOISES

where

N = the indicated noise level obtained by instrumental means.

Thus, having a knowledge of the noise level and acoustic absorption units present at a test in the manufacturing plant it is possible to determine the noise level that might be expected following installation in a final location. In actual practice the relations shown will not necessarily hold entirely true due to the theoretical assumptions made. Correction should be made for the deviations in the assumption. The detailed methods of making these corrective calculations are not within the scope of this paper.

The fact that certain assumptions must be made makes it imperative that standard conditions be imposed for making all measurements of noise level. It is deemed highly desirable to make all measurements of noise in some selected test room arranged so that all variation of the acoustic factors be either eliminated or reduced to a minimum. In addition, it is absolutely necessary to maintain the normal performance of the equipment being tested so that no unusual factors be introduced that would not be finally present. By this is meant that a blower should be tested with a fixed length, or several selected lengths, if found desirable, of standard duct structure with normal static pressure and air delivery. Overall noise measurements can then be made which would include both the air and mechanical noise. Likewise, standard tests should be made and measurements obtained so that the only introduction of noise into the measuring room can be through the duct system. This should more nearly simulate usual operating conditions, with a well-installed system in a well-constructed building. In this last case, studies of the air noise as introduced into the room can be made. In a ventilating system, movement of air by the blower above its critical velocity causes vortex motion and turbulent conditions which in turn is manifested by noise. Using standard test and measuring conditions, studies can be made of noise conditions with respect to the static pressure, speed of the blower, duct section, material of duct structure and other determining factors which will generally be comparable.

By using some standard test procedure for measuring noise, the following benefits are obtainable:

1. Shop measurements may be converted into performance ratings in any given location
2. A basis of rating equipment on noise performance may be established
3. Standards of minimum allowable noise for different types of systems, relative to air delivery, etc., may be established
4. All data taken will be capable of correlation and comparison, permitting more rapid accumulation of empirical data

All of these seem necessary in view of the increasing interest in the subject of noise, and the demand for consideration of this factor in the design of many modern structures.

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A. G. A. Issues Third Edition of House Heating

The ever increasing demand for information on gas house heating has exhausted the many printings of the Industrial Gas Series on House Heating, issued by the *American Gas Association.*

Much new material has been added to the 3rd Edition which has recently been made available to the public. The tables of degree-days have been enlarged to include nearly 1000 cities, and a new degree-day map of greater accuracy has been prepared. Chapter II on Combustion and Fuels has been changed to conform to new material developed since the earlier issues.

New Data on Warm Air

Chapter IV includes new data for the selection of warm air furnace sizes, and mention is made of the important developments in fan furnace heating systems. Additional material has been added on the subject of flues, with particular reference to the question of handling of excessive condensation. Chapter VII has been extended to include the 1930 requirements for house heating appliances, whereas Chapter VIII has been revised to bring the approval requirements for space heaters in conformity with 1930 specifications. Chapter IX should be of special value in "trouble shooting." The following quotation from Sec. 26a of this publication is of special interest to members of the Society:

"*The American Gas Association, The Heating and Piping Contractors National Association,* and the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS have come to an understanding in regard to the use of basic constants for thermal conductivity. It was decided that the A. S. H. V. E organization was in the best position to establish the accuracy of the constants. For this reason the three organizations have agreed to publish, in forthcoming editions of their various publications on house-heating data which would be based on the work of the Society. The *American Gas Association* is glad to co-operate in such an endeavor, particularly as they have received permission to reprint from the A. S. H. V. E. GUIDE 1930 the splendid tables of Heat Transmission Coefficients which will be found in the Appendix replacing the data formerly used by the American Gas Association. The Gas Industry expresses its gratitude and thanks to the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS for their most helpful assistance in granting the privilege of reprinting the tables."

This publication is ably edited by C. George Segeler of the *American Gas Association,* and is priced at $3.00 per copy.

An Automatic System of Hot Water Heating and Hot Water Supply

By Erwin L. Weber[1], Seattle, Wash.
MEMBER

THE problem of providing heat, domestic hot water and clothes drying facilities for medium size apartments, hotels, hospitals and other commercial buildings at the minimum initial cost and operating expense, has been difficult to solve in a satisfactory manner, when the expense of employing an operating engineer or fireman was not warranted.

Usually, the operation of the heating plant is in charge of the janitor, or his wife, and his many other duties about the building prevent him from spending a great deal of time in the boiler room. Hence the systems for such buildings must be designed to be as nearly automatic in operation and as foolproof as possible, and at the same time simple enough for the average janitor to maintain with the minimum of labor.

Combination Systems Used in Pacific Northwest

In the Pacific Northwest, an unusually large number of buildings are heated by means of forced hot water heating systems. Many of these installations are equipped with double-shell circulating tanks, which consist of an inner tank for the storage of the domestic hot water, surrounded by an outer shell. Hot water from the heating system flows through the space between the two shells and heats the domestic hot water in the inner tank.

To obtain domestic hot water at about 160 F in these systems irrespective of the weather conditions or the temperature outdoors, the temperature of the water in the heating boiler is always automatically maintained at about 180 F, which is the maximum water temperature for which the heating system is designed to warm the building during the most severe winter weather. This maximum temperature is continuously carried in the boiler, even during the summer, merely to heat the domestic hot water supply for the building.

Obviously, the operation of the system in this manner is very wasteful of fuel because the average load of any heating plant during the heating season is less than 50 per cent of its maximum load, usually about one-third, and hence the average temperature of the water in the boiler need be only about 140 F during the heating season. Unnecessarily high temperatures mean a waste of fuel due to the excessive loss of heat through exposed and insulated surfaces, and to the higher flue gas temperatures encountered. Furthermore, water at a high temperature will extract less heat from the gases of combustion than will water at a low temperature. These items probably represent from 6 to 10 per cent of the annual fuel consumption.

Fuel economy is obtained in hot water heating by the reduction of the temperature of the water during all but the coldest weather. As the temperature of the water in these systems is always 180 F, this important item of fuel economy is lost. Attempts are made to economize on fuel by starting and stopping the circulating pump under the control of a room thermostat. This produces *spasmodic* heating of the building in place of the much desired uniform heating so familiarly associated with hot water heating systems. For a while the rooms are overheated and the windows thrown open and then a period of underheating occurs. This is undesirable as well as uneconomical and results in a waste of fuel variously estimated at between 8 and 12 per cent of the total fuel consumption during the heating season.

During the entire non-heating season and during all mild weather it is necessary to heat the total water content of the system to at least 180 F several times a day to secure the necessary domestic hot water supply at 160 F. To this must be added the fuel required to heat the refractory brick lining of the oil-burning furnace several times a day. Such operation is obviously wasteful of fuel as a large portion of the heat in the fire brick lining is lost after the oil burner is shut off, due to the circulation of secondary air through the furnace and up the chimney.

In a number of installations, gas-fired boilers are used for supplying the domestic hot water. While this is advantageous during the summer, it proves to be quite costly during the winter season. A separate automatic oil burner (or stoker) for domestic water heating is usually too expensive to install.

Description of Automatic System

With a view of eliminating the various objectionable features cited and providing an economical automatic system of hot water heating and domestic hot water supply, the author has recently designed a system (Fig. 1) which is now being installed in several apartment houses in Seattle. The equipment and appurtenances used are described in Table 1. In this system, the oil burner (or stoker) is controlled by room thermostat *TH-1* and the temperature of the water in the heating boiler is only sufficient to maintain the desired temperature in the building. This temperature ranges between 80 F in very mild weather to 220 F in the most severe weather.

The cold water for the domestic hot water supply enters hot water storage tank *5* through supply line *51* and the perforated pipe *52* in the bottom thereof. Tank *5* has a heating coil *6* supplied with water from the heating system from boiler *1* through lines *11* and *14*. The water in the tank is thereby heated to a temperature somewhat lower than the temperature of the water in the boiler.

The heated water then passes through *53* and per-

[1] Consulting engineer.

forated pipe *54* to hot water tank *7*, and from there through hot water supply riser *55* to the various fixtures. The hot water return circulation passes through *56* and check valve *57* set at 45 deg to *58*, then either through coil *9* when the clothes dryer is in operation or through by-pass *61* to line *62*. Let it be assumed that the normal operating temperature of the domestic hot water supply is 160 F and that all thermostats are set accordingly to perform the functions indicated. Whenever the temperature of the water in the boiler is sufficient to raise the temperature of the water in tank *5* to 160 F or over, then thermostat *TH-4* automatically closes valve *69* and opens valve *66*. Hence the circulating hot water passes from *62* through *66*, *65* and *67* to tank *5*; then through *53* and *54* to tank *7*, in which case both tanks are supplied with hot water at a temperature of 160 F or higher. The heat needed to produce circulation is thus also derived from boiler *1*. Thermostat *TH-3* and diaphragm valve *13* are provided to avoid heating the water above a predetermined maximum.

Effect of Outdoor Temperature

When the outdoor temperature moderates, the action of thermostat *TH-1* brings about a drop in the temperature of the water in boiler *1*. When this drop is sufficient to cause the temperature of the water in tank *5* to fall below 160 F, thermostat *TH-4* automatically opens valve *69* and closes valve *66*. Thermostat *TH-5* simultaneously opens gas valve *73* and the gas water heater is placed in operation. The hot water return circulation then passes from *62* through *63* to *8* and up *64* to tank *7*. The local or tank circulation will follow the path from *7* through *68*, *69* and *63* to *8* and up *64* to tank *7*. The cold water supply to tank *7* comes from *51*, through *52*, *5*, *53* and *54* and is warmed in tank *5* to whatever degree of heat the water in coil *6* is able to impart to it. Under such conditions of operation, the gas heater acts as a booster only. It provides the final degree of heat to the water which was pre-heated in tank *5* before entering tank *7* and it also provides the heat needed to produce circulation. As the temperature of the water in tank *5* is not affected by the gas heater, the water in this tank becomes merely a tempered water supply to tank *7*.

When hot water is drawn at a fixture and cold supply water enters at *51*, it is slowly distributed through *52* over the bottom of tank *5*, where it makes intimate contact with coil *6* and is warmed to the greatest degree possible with the flow water from the boiler.

When the action of thermostat *TH-1* causes the temperature of the water in the heating system to rise sufficiently to heat the domestic water supply in tank *5* to 160 F, or over, then valve *69* automatically closes and valve *66* opens by the action of thermostat *TH-4*, and the hot water return circulation again passes through both tanks. Thermostat *TH-5* simultaneously shuts off the gas at valve *73*, as it is no longer required as a booster.

Operation During Summer

During the summer when no heat is needed in the building, the heating system is shut off by closing valve *21*. The boiler is periodically operated for a short time to fill both tanks with water at a temperature of 160 F, or over. After the boiler is shut down and the temperature at thermostat *TH-5* falls below 160 F, the gas water heater will again resume operation as a booster. Whenever hot water is drawn at *55*, its place will be taken by cold water entering tank *5* through *51* and *52* and it will be warmed by coil *6*. Due to the fact that there is now no circulation through tank *5* and that the cold water is supplied through pipe *51* which has openings pointing downward, the hot water in tank *5* will remain at the top of the tank and the cold water in the bottom; in other words it will lie in strata of different temperatures from the coldest water in the top of the tank. The incoming cold water will therefore gradually push the

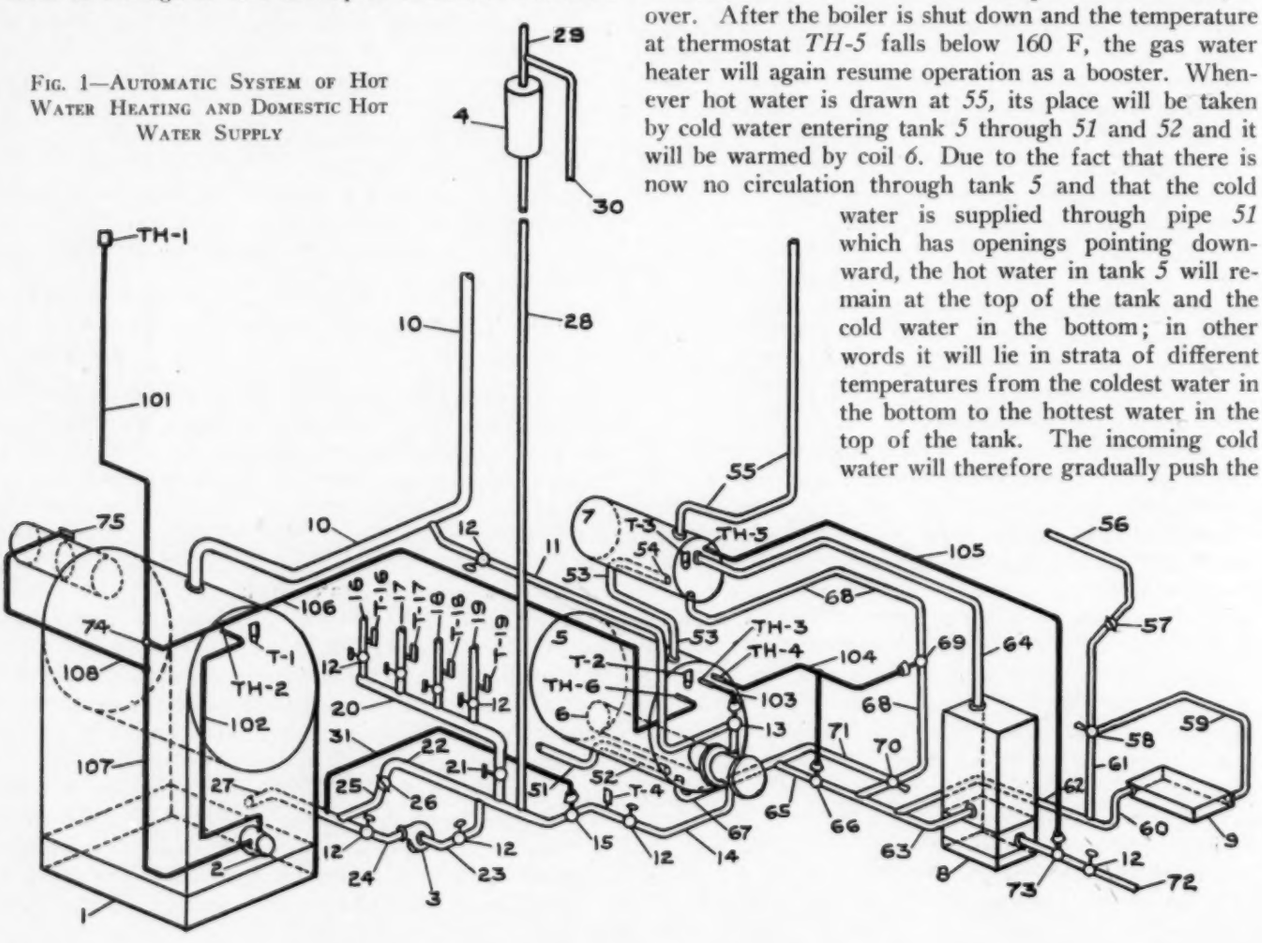


Fig. 1—Automatic System of Hot Water Heating and Domestic Hot Water Supply

TABLE 1—SCHEDULE OF EQUIPMENT AND APPURTENANCES SHOWN IN FIG. 1

1. Heating Boiler.
2. Oil Burner (or stoker).
3. Circulating Pump.
4. Expansion Tank.
5. Hot Water Storage Tank.
6. Heating Coil in *5*.
7. Hot Water Tank.
8. Gas Water Heater.
9. Coil in Clothes Dryer.
10. Flow Main.
11. Flow Line to Coil *6*.
12. Shut-off Valve.
13. Diaphragm Valve.
14. Return from Coil *6*.
15. Diaphragm Valve with Hole.
16. Return Main, Zone No. *1*.
17. Return Main, Zone No. *2*.
18. Return Main, Zone No. *3*.
19. Return Main, Zone No. *4*.
20. Heating Returns Header.
21. Heating System Shut-Off.
22. Return Header.
23. Circulating Pump Suction.
24. Circulating Pump Discharge.
25. Gravity Circulation By-Pass.
26. Check Valve set at 45 deg.
27. Return to Boiler.
28. Expansion Line.
29. Vent Line.
30. Overflow Line.
31. Pressure Line to *15*.
51. Cold Water Supply to Tank *5*.
52. Distributing Pipe with Holes in Bottom.
53. Supply from Tank *5* to Tank *7*.
54. Distributing Pipe with Holes in Bottom.
55. Hot Water Supply Riser.
56. Hot Water Return Circulating Line.
57. Check Valve set at 45 deg.
58. Three-Way Cock, from *56* to *59* or *61*.
59. Supply to Coil *9*.
60. Return From Coil *9*.
61. By-Pass around Coil *9*.
62. Return Circulating Line.
63. Circulating Line to Gas Water Heater *8*.
64. Hot Water Line from Gas Water Heater *8*.
65. Return Circulating Line.
66. Diaphragm Valve.
67. Circulating Line to Tank *5*.
68. Circulating Line to Tank *7*.
69. Diaphragm Valve.
70. Three-Way Cock from *68* or *71* to *63*.
71. By-Pass around *66*.
72. Gas Supply to Gas Water Heater *8*.
73. Gas Regulating and Supply Valve.
74. Three-Way Switch or Three-Way Cock.
75. Damper Regulator. Full Acting.
T-1. Thermometer on Boiler *1* (60 F to 240 F).
T-2. Thermometer on tank 5. (40 F to 200 F).
T-3. Thermometer on Tank *7*. (60 F to 220 F).
T-4. Thermometer on Return *14*. (60 F to 220 F).
T-16, T-17, T-18, T-19. Thermometers on Return Mains *16, 17, 18, 19*. (60 F to 220 F).

TH-1. Room Thermostat, set at 70 F, with Line *101* and *107* to Oil Burner *2*, and Line *108* to *75*.
TH-2. Safety Thermostat, set at 222 F, with Line *102* to Oil Burner *2*.
TH-3. Safety Thermostat with Line *103* to *13*. Set at 175 F (or other maximum).
TH-4. Thermostat, set at 160 F, with Line *104* to *66* and *69*, to close *69* and open *66* when *TH-4* exceeds 160 F, and to open *69* and close *66* when *TH-4* falls below 160 F.
TH-5. Thermostat, set at 160 F, with Line *105* to Gas Regulating and Supply Valve *73*.
TH-6. Thermostat, with Line *106* to *74*. Set to start Oil Burner *2* at 90 F, and to shut off Oil Burner *2* at 160 F. To function in place of Thermostat *TH-1* in Summer.

warmer water out of the top of the tank. This action produces the maximum cooling effect of the incoming cold water on coil *6*, thus insuring the fullest utilization of the heat content of the water in boiler *1* and the refractory brick lining of the furnace. Such action would not be possible if circulation existed in tank *5*. This mode of operation during the summer may be made entirely automatic by installing thermostat *TH-6* in tank *5* with line *106* to *74*. If thermostat *TH-1* is electrically operated, then *74* is a three-way transfer switch, and if operated by fluid pressure it is a three-way cock, so arranged that the control of the oil burner is transferred from *TH-1* to *TH-6*. This thermostat may be set to start the oil burner when the temperature at *TH-6* falls to, say, 90 F, and to shut off the oil burner when 160 F is reached.

When a type of oil burner is used which supplies only primary air of combustion and atomization, and the secondary supply of air enters the furnace through tuyeres or other openings, then, whenever the oil burner is shut off, circulation of air will continue through the furnace and up the chimney, thus rapidly dissipating the heat content of the refractory brick lining in the furnace. To conserve this heat, a damper, *75*, is provided in the breeching with line *108* connected to line *107* and arranged so that the damper will close automatically whenever the oil burner is shut off, and opened when the oil burner is turned on.

If, during the summer, it is desired to heat both tanks from gas heater *8* only, then, when *69* is open and *66* is closed, the three-way cock *70* is turned into position to feed from *71* to *63*. The path of the tank circulation from the gas water heater will then be: *8, 64, 7, 53, 5, 67, 71, 70, 63, 8*, thus filling both tanks with hot water. By turning three-way cock *70* back into position *68* to *63*, the previous cycle is re-established wherein *5* serves as a pre-heated water storage tank and the final heating of the water is accomplished in tank *7* through the operation of gas water heater *8*. During the emergency of extremely severe weather, the gas water heater only may be used for furnishing the domestic hot water supply, thus leaving the entire capacity of the boiler available for heating purposes.

Lines *16, 17, 18* and *19* are the returns from various zones of the building arranged according to different points of the compass. Each is provided with a valve, *12*, and with the thermometers, *T-16, T-17, T-18* and *T-19*. By throttling the valve on the leeward or sunny side, zone control is readily accomplished within the boiler room itself without the use of any remote-controlled mechanisms. The extent of such control can be readily gaged by the thermometer indications, which are

not subject to the uncertainties found in mechanisms having parts subject to wear and clogging.

A by-pass, *25*, with check valve *26* is set at an angle so that it is normally open to permit of gravity circulation when the pump is not in operation. When the pump is in operation, check valve *26* is automatically closed due to the greater pressure in discharge line *24* over that in return header *22*.

Pump and Diaphragm Valve

Number *15* is a diaphragm valve having an opening in it. When the pump is not in operation, the valve is wide open to readily permit the circulation of hot water by gravity through coil *6*. When the pump is in operation, the pressure in line *24* is transmitted through line *31* to diaphragm valve *15*. This closes the valve and the hole therein avoids short-circuiting the water through coil *6* by restricting the circulation through this coil.

Thermostats *TH-1*, *TH-2* and *TH-6* are preferably of the electrically-operated type with motor valves. *TH-3* is of the bulb- and sylphon-valve type. *TH-4* is of similar type consisting of one bulb with one direct-acting and one reverse-acting sylphon diaphragm valve, or it may have two bulbs, one for each diaphragm valve. *TH-5* and *75* are parts of a standard gas regulator.

When it is desired to operate the clothes dryer, coil *9* is heated from the hot water return circulation from line *56*, by turning three-way cock *58* so that the circulation passes through *59*, *9* and *60* to *62*. As a supply of domestic hot water is always present, the clothes dryer may be operated at any time, summer or winter, without operating the boiler.

This system uses oil (or coal) to the fullest possible extent for the heating of the domestic hot water supply, without carrying wastefully high temperatures in the heating system during mild weather, and uses gas as a booster fuel only, all under fully automatic control.

The demand for gas usually occurs when the gas load for general heating purposes is at a minimum and seldom, if ever, occurs when this load is at a maximum. It therefore provides an ideal off-peak gas load and thus insures the lowest available gas rate.

With this system the flow temperature may be as high as 220 F in place of 180 F as is employed in most systems. Hence, 25 per cent less radiation can be used. The saving thus effected in many cases pays for the gas heater, hot water tank and the additional automatic control system. Being completely automatic, this system insures the greatest possible fuel economy and requires the minimum of attention and labor in its operation.

Code for Pulverized Fuel Systems

A revision of the American Standard Safety Code for the Installation of Pulverized Fuel Systems is announced by the *American Standards Association*. The rapid increase in the use of pulverized fuel in many industries, resulting in new developments in methods and design of equipment, is responsible for the revision. The original code was approved by the *American Standards Association* in 1927.

The code covers the construction of buildings housing fuel pulverizing equipment, the ventilation of these buildings, and specifications for dust-collecting systems. Specifications are given covering methods of preventing explosions through static, through the drying of coal, and through its transportation through pipe lines. The code also contains suggestions for safe operating rules to be printed on instruction cards which can be used for the guidance of the employes in charge of the operation of such systems.

The standard, which is part of a comprehensive project for the prevention of dust explosions, was developed, and the revision undertaken, under the sponsorship of the *National Fire Protection Association* and the United States Department of Agriculture. The A. S. A. Technical Committee in charge of the project is under the chairmanship of D. J. Price, Bureau of Chemistry, U. S. Department of Agriculture, Washington, D. C.

Copies of the code may be obtained from the American Standards Association, 29 West 39th Street, New York City.

Coal and Coke Analysis Standard

The *American Standards Association* has approved American Standards methods of laboratory sampling and analysis of coal and coke submitted by the *American Society for Testing Materials*, which is the proprietary sponsor for the project under A. S. A. procedure.

These methods were originally prepared by joint committees of the *American Society for Testing Materials*, *American Chemical Society*, and the *American Foundrymen's Association*. They were adopted by the *American Society for Testing Materials* in 1916 and 1918, and were revised in 1921, 1924, 1927, 1929 and 1930 by the committee on coal and coke of the *American Society for Testing Materials*.

Revisions Are Minor Changes

The recent revisions of the methods consist of minor changes in some of the methods of test and do not radically alter any of the procedures. These changes are the result of investigations of the methods of analysis with a view of increasing their accuracy. Many of the determinations made in analyzing coal and coke are in part empirical in nature and methods of this character require close standardization to secure good agreement between different laboratories.

Standards Used Widely

The standards just adopted are generally recognized and used by most of the large consumers of coal in the United States. The methods are extensively used in purchasing coal under specifications for power production. They are also used by large coal producers who process their coal before marketing to improve its quality, and are in general use for evaluating coals for gas and coke plants. The methods of coke analysis are principally used for evaluating coke for metallurgical purposes. The acceptance of the methods by the *American Standards Association* will broaden their recognition and use in this country.

Detroit-Windsor Tunnel Opened

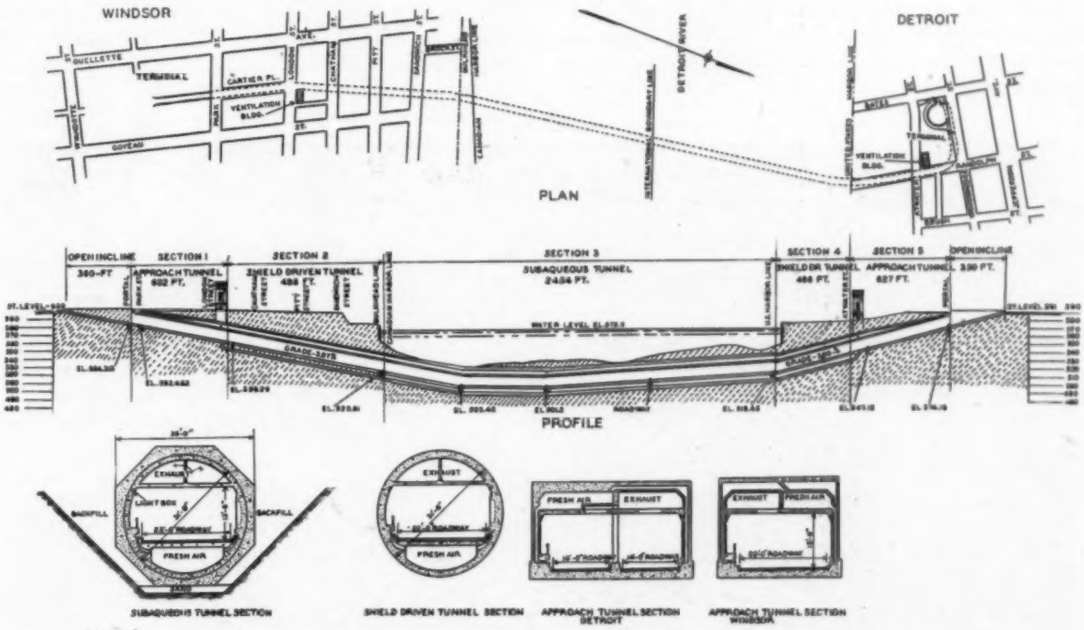
THE Detroit-Windsor Tunnel is the third underwater vehicular tunnel in use in the United States, but is the first one connecting two nations. This international auto subway was formerly dedicated Saturday, November 1, when President Herbert Hoover from his office in Washington, gave the signal for cutting the silk ribbon stretched across the tunnel at the international boundary line between Canada and the United States, 75 ft. below the surface of the Detroit River.

Over 5,000 persons gathered at the Detroit Plaza and as many more were present at the Windsor Plaza. The speakers on the American side were Fred W. Green, Governor of Michigan; Frank Murphy, Mayor of Detroit; U. S. Senator A. H. Vandenberg; and Col. Hanford MacNider, U. S. Minister to Canada, while on the Windsor side the speakers were Mayor C. E. Jackson of Windsor; Hon. George S. Henry, Ontario, Minister of Highways; Col. S. C. Robinson, M. P., and Hon. Thomas G. Murphy, Minister of the Interior of the Dominion of Canada.

The Detroit-Windsor Tunnel extends from the center of Detroit's business district to the heart of Windsor's business district. The tunnel is a mile long with a roadway 22 ft. wide; it required 2½ years to build and cost $25,000,000.

Three methods of construction were employed in building this under river highway and probably the most spectacular part of the construction work was the fabrication, floating and sinking of the nine steel tubes which comprise the under water section.

The subway approach on the American side is 627 ft. while



Cross Section of the Tunnel

LARGE VENTILATING FAN

the Canadian subway section is 600 ft. The American shield driven section is 446 ft. and the Canadian shield driven section is 1,243 ft. The under river section totals 2,200 ft. and lies in a 50 ft. trench which was dredged across the river.

The ventilation arrangements provide for complete air change every minute and a half. Four-story ventilation towers are located on each side of the river and each structure provides ventilation for half of the tunnel. Twelve fans are located in each building, and one-third are held in reserve. One hundred horsepower motors drive the fans for the river section, and 30 horsepower motors are attached to the fans ventilating the land section.

The air supply is taken in at the side of the building, sent down under the roadway, and comes into the tunnel through apertures near the curb. The air is exhausted from the tunnel through openings located at regular intervals, and is drawn to the ventilation building and exhausted at the top. Four CO recorders are in service, two on each side of the river and connected with the land and river exhaust ducts. Electric power for operating mechanical equipment comes from three substations of the Detroit Edison Co. on the American side, and two sources on the Canadian side.

The ventilating system is patterned after that used in the Holland Tunnel in New York.

The tunnel engineers were Parsons, Klapp, Brinckerhoff and Douglas. The executive engineer in active charge of the work was Col. B. R. Value, and the designing engineer was S. A. Thoresen, while the electrical and mechanical ventilation design was handled by William C. Dunlop.

One of the unusual problems in connection with the Detroit-Windsor Tunnel was provision for customs and immigration inspection. It was necessary to separate incoming and outgoing traffic and provide areas for clearing of automobiles, trucks and buses with a minimum of waiting. Special buses run between Detroit and Windsor for those who wish to commute between the two cities. At Windsor the buses start inside of the tunnel terminal property and depart from covered platforms. Arriving in Detroit, passengers leave the bus for customs and immigration inspection, then return to the bus and ride to the heart of the city. Special buses are provided for those carrying immigration cards, as they can be passed by United States Immigration Inspectors in Windsor and go direct to the heart of Detroit without change.

The capacity of the tunnel is figured for 2,000 vehicles per hour.

INTERIOR VIEW OF TUNNEL SECTION

Pittsburgh Prepares Pleasing Program January 26-29

UNDER the leadership of H. Lee Moore, general chairman of the Arrangements Committee for the Pittsburgh Chapter, plans have progressed rapidly for the 37th Annual Meeting of the Society to be held at the William Penn Hotel, January 26 to 29, 1931.

Eight Sub-Committees are handling Program, Reception, Registration, Banquet, Entertainment, Transportation, Publicity and Finances.

The meeting will be called to order by Pres. L. A. Harding, Buffalo, at 2:00 p. m. Monday, January 26, at the William Penn Hotel and on each day thereafter technical sessions will be held. On Wednesday all scheduled events will be transferred to the Society's Research Laboratory at the U. S. Bureau of Mines Experiment Station where a technical program will be given in the morning and the afternoon will be devoted to inspection.

In addition to an attractive program of technical papers, consideration will be given to several Codes which have been developed during the past year; the two which have already been reported to the Council are the Code on Oil Burning Devices and the Code for Testing and Rating Concealed Gravity Type Radiation.

Some of the papers that have been offered for the meeting include the following subjects: Insulating Effect of Successive Air Spaces Bounded by Bright Metallic Surfaces by L. W. Schad; Special Distribution of the Energy Radiated from Metallic Surfaces at High Temperatures by G. R. Greenslade; Wind Velocities and Temperature Gradient Near Surfaces, by Houghten and McDermott; A Quarter Century of Development in Heating and Ventilating by R. P. Bolton; Developments in Heating and Ventilation during 1930 by S. R. Lewis; Some Studies on the Absorption of Noise in Ventilating Ducts by G. L. Larson and R. F. Norris; Noise and Ventilation by G. T. Stanton; Noise Reduction in Ventilating Units by Warren Ewald; Air Leakage through Various Forms of Building Construction by Houghten, Gutberlet and Herbert; Welded Piping for Building Heating Systems by F. G. Outcalt, and Air Conditioning for Railway Cars by A. H. Candee.

Other papers are coming so that a diversified and interesting program is in prospect.

In planning the trip to Pittsburgh reduced fare will be in effect under the Identification Certificate Plan. Railroads have authorized this plan and the certificates will be mailed to members in advance of the meeting so that they may purchase round trip tickets to Pittsburgh at their home station.

Pittsburgh is within a night's ride of every Chapter city with the exception of Kansas City, Los Angeles and Seattle and the distance and one way railroad fares are shown as follows:

	Mileage	One-way Railroad Fare	Lower Berth
New York, N. Y.	440	$15.82	$4.50
Boston, Mass.	669	24.06	6.38
Toronto, Ont.	357	12.87	4.50
Philadelphia, Pa.	348	12.58	3.75
St. Louis, Mo.	612	22.24	6.38
Chicago, Ill.	468	16.88	4.50
Milwaukee, Wis.	553	19.94	5.25
Detroit, Mich.	295	10.65	3.75
Cleveland, O.	131	4.73	3.00
Buffalo, N. Y.	257	9.20	3.75

LOBBY, WILLIAM PENN HOTEL

Two weeks in advance of the meeting hotel registration cards will be furnished to members and reservations will be promptly taken care of by the staff of the William Penn Hotel, the meeting headquarters.

Rates at the hotel range from $3.50 to $7.00, single room with bath; $6.50 to $10.00, double room with bath, and $7.00 to $10.00 for rooms with twin beds.

There are many things to see in Pittsburgh, both from an historical standpoint as well as from the viewpoint of the visitor interested in art, education or industrial development.

Here in the Steel City are located some of the world's most famed plants and among them are many that produce heating and ventilating equipment. The local committee is prepared to make arrangements for members who desire to visit plants such as Armstrong Cork, Byers, National Tube, Westinghouse, or any others specified.

Pittsburgh not only has a variety of industries but is the home of Heinz 57 Varieties and is the birthplace of radio broadcasting, the pioneer station KDKA having just celebrated its tenth anniversary.

Art galleries, libraries, institutions of learning, and parks dot the city as well as points of historical interest.

Pittsburgh will be a pleasant place to spend a few days January 26-29.

SCHEDULE OF TECHNICAL MEETINGS
37TH ANNUAL MEETING
AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
JANUARY 26 TO 29, 1931, WILLIAM PENN HOTEL, PITTSBURGH

First Session, Monday, January 26
2:00 p. m.—William Penn Hotel
Reports and Technical Papers

Second Session, Tuesday, January 27
9:30 a. m.—William Penn Hotel
Reports and Technical Papers

Third Session, Tuesday, January 27
2:00 p. m.—William Penn Hotel
Reports and Technical Papers

Fourth Session, Wednesday, January 28
9:30 a. m.—A.S.H.V.E. Research Laboratory
Reports and Technical Papers
2:30 p. m.—Inspection A.S.H.V.E. Laboratory and Bureau of Mines.

Fifth Session, Thursday, January 29
9:30 a. m.—William Penn Hotel
Reports and Technical Papers

Sixth Session, Thursday, January 29
2:00 p. m.—William Penn Hotel
Reports and Technical Papers

MAIN DINING ROOM, WILLIAM PENN HOTEL

SIXTH AVENUE, SHOWING TRINITY CATHEDRAL AND FIRST PRESBYTERIAN CHURCH

Get a Member

Since the membership campaign opened on November 15, there has been a splendid response from all of the Chapters. There is evidence of a keen desire to strengthen the membership in this fall campaign and bring the Society membership up to a record number by January 15, 1931.

Two letters have been sent to members with application blanks, and places where members may be obtained have been suggested.

The regulations for the campaign are simple:

1. The Society member whose name appears as first proposer on the greatest number of membership applications between October 15, 1930, and January 15, 1931, will receive a gold watch with Society emblem; for the *second* greatest number a copy of Vol. 2, *Heating and Ventilation* (revised) by Harding and Willard; for the *third* greatest number a pair of cuff links with Society emblem; for the *fourth* greatest number a watch fob with Society emblem and for the *fifth* greatest number a solid gold Society pin.

2. For the Chapter whose percentage of membership is increased by the greatest amount between October 15 and January 15 a banner will be awarded and will remain in possession of the Chapter for one year.

3. Officers of the Society and members of the Council are not eligible for the prizes listed.

4. Awards are to be made at the banquet of the Annual Meeting in Pittsburgh.

5. All applications must be properly filled in as required by the Society's Constitution and By-Laws and initiation fee check must be attached.

NOMINATIONS FOR OFFICERS OF THE SOCIETY FOR 1931

The Nominating Committee appointed to select candidates for Officers of the Society for the coming year, 1931, takes pleasure in submitting the following list of nominees:

For President:
W. H. CARRIER, Newark, N. J.

For First Vice-President:
F. B. ROWLEY, Minneapolis, Minn.

For Second Vice-President:
W. T. JONES, Boston, Mass.

For Treasurer:
F. D. MENSING, Philadelphia, Pa.

For Members of the Council:

Three-Year Term

D. S. BOYDEN,* Boston, Mass.
E. K. CAMPBELL, Kansas City, Mo.
E. O. EASTWOOD, Seattle, Wash.
ROSWELL FARNHAM, Buffalo, N. Y.
E. HOLT GURNEY, Toronto, Ont.

Respectfully submitted,

NOMINATING COMMITTEE

G. L. LARSON, *Chairman*

Chapters	*Representative*
Cleveland	H. M. NOBIS
Illinois	J. F. HALE
Kansas City	N. W. DOWNES
Massachusetts	J. F. TUTTLE
Michigan	J. H. WALKER
Minnesota	G. C. MORGAN
New York	H. B. HEDGES
Western New York	O. K. DYER
Ontario	A. S. LEITCH
Pacific Northwest	E. O. EASTWOOD
Philadelphia	R. C. BOLSINGER
Pittsburgh	T. M. DUGAN
St. Louis	C. A. PICKETT
Wisconsin	G. L. LARSON

In accordance with the provisions of the Amended Constitution, as given, ballots containing the names of the above candidates will soon be sent to the membership for voting upon prior to the Annual Meeting in January.

Art. 9—*Section* 2. The Nominating Committee shall consist of a member designated by each Chapter, which shall effect its own organization and elect its own Chairman.

Section 3. The Committee may meet at the call of the Chairman, for discussion, but the official meeting shall be held at the Semi-Annual Meeting of the Society, at which time the candidates for each of the offices of the Society to be filled at the next Annual Meeting shall be selected by a majority vote of the members of the Committee present and voting. Five shall constitute a quorum.

Section 4. The Committee shall first secure the consent of all candidates selected, and shall, if possible, announce the names of the candidates at the Semi-Annual Meeting, but in any case the names of the candidates shall be certified to the Secretary of the Society at least four months before the next Annual Meeting. The Secretary shall publish these names in the October issue of THE JOURNAL.

Art. 10.—*Section* 3. The Secretary shall prepare ballots with the names of all candidates and forward them to the members at least thirty (30) days before the date of the Annual Meeting.

*Nominated to fill an unexpired term for two more years beginning 1931.

Nominations for Members of Committee on Research

Although committees of the Society are usually appointed, in view of the great importance of the Committee on Research and the financial responsibility it would be called upon to assume, it has been made more representative of the entire membership of the Society by a process of *election*. The election is governed by the By-Laws for the election of officers, with the single exception, that Members of the Committee on Research are nominated by the Council instead of by a Nominating Committee.

In accordance with the Regulations for the government of the Research Laboratory, adopted at the January, 1919, Meeting, and revised January, 1930, the Council announces the nomination of the following members of the Committee for election to succeed those members whose present terms expire January, 1931:

C. A. BOOTH, Buffalo, N. Y.
F. B. HOWELL, New York, N. Y.
WALTER KLIE, Cleveland, O.
F. B. ROWLEY, Minneapolis, Minn.
J. H. WALKER, Detroit, Mich.

The regulations governing the nomination and election of members of the Committee on Research are as follows:

SECTION I—ORGANIZATION

Research Committee

1. There shall be a standing committee known as the Research Committtee, consisting of fifteen members, each serving for three years, and five retiring each year.

a. The Council shall nominate previous to October first of each year five members to fill the vacancies of those retiring at the next Annual Meeting.

b. The nominations made by the Council shall be published in the October issue of the Society's Journal.

c. Prior to December first of any year, any ten members, over their own signatures, may nominate one or more additional members of the Research Committee, and such additional nominations shall be placed on the ballot opposite the nominations made by the Council.

d. The election shall otherwise conform to the regulations provided for the election of officers of the Society.

e. Vacancies may be filled by the Council, such persons chosen by the Council to serve until a successor is elected at the next Annual Meeting.

The Council Nominates Members for Committee on Research

AT THE August 11 meeting of the Council in Buffalo, N. Y., action was taken in accordance with the requirements of the Society's Constitution and By-Laws and five men were nominated for membership on the Committee on Research for a three-year term and their names were published in the October Journal.

A brief description of their careers is given for the information of the Society members who will receive ballots for voting late in December.

C. A. Booth

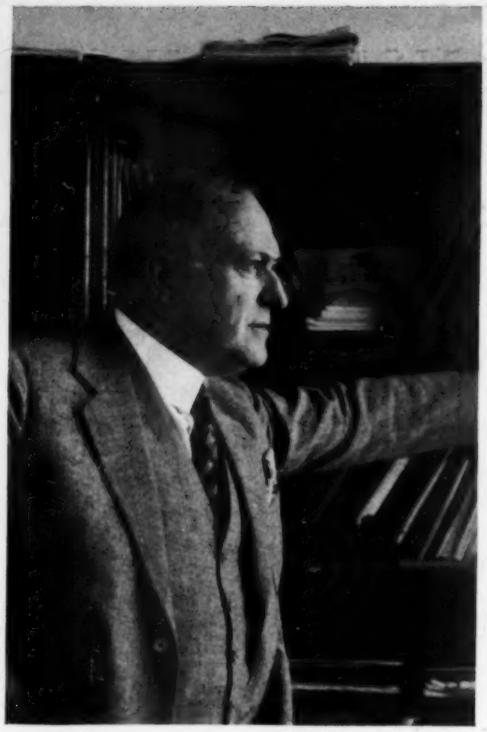
Charles A. Booth, Buffalo, N. Y., was born at Southbridge, Mass., and almost became a New Year's arrival as he was born December 31, 1876. His preparatory education was taken at Worcester Academy and in 1898 he graduated from Worcester Polytechnic Institute with a degree of B. S.

After teaching science for two years at Williston Seminary, Easthampton, Mass., he started his career in the field of heating and ventilating at the opening of the 20th Century with the Buffalo Forge Co., Buffalo, N. Y.

During the past thirty years of service with this firm, he has successfully done sales work in the New England territory, has supervised design and layout of fan installations, and served as Office Manager, Sales Manager and Vice-President, the position he now holds.

Mr. Booth became a member of the Society in 1917 and has served on many of its Technical Committees and has always been a strong supporter of its research activities. Other engineering organizations to which he has devoted much time are the *A.S.M.E.* and the *American Engineering Council.*

C. A. Booth



F. B. Howell

F. B. Howell

F. B. Howell, New York City, is a native New Yorker, having been born in Yonkers, N. Y., July 28, 1867, and except for the first few years of his business life his headquarters have remained between two of its boundary cities, New York and Buffalo.

Mr. Howell has devoted his life largely to the heating industry in the manufacturing and selling divisions and because of his aptitude for development work for 14 years he was head of the Institute of Thermal Research for the American Radiator Co. at Buffalo, N. Y.

After receiving his early schooling in Yonkers Mr. Howell attended Peter Cooper Institute in New York and Lowell Institute in Boston. His start in business was with Howard Mfg. Co. after which for several years he designed heating boilers for the Richmond Stove Co.

With the American Radiator Co. he has been salesman, branch manager, plant manager, assistant general manager of sales and director of research.

In addition to his service on many technical committees for the Society since 1920, including a term on the Committee on Research, he finds time to do much committee work for the *A.S.M.E., National Research Council, American Engineering Standards Committee* and the *Institute of Boiler and Radiator Manufacturers.*

Walter Klie

Walter Klie of Cleveland has a 100 per cent Ohio background, having been born in Columbus Nov. 23, 1881, educated in the city schools and graduating from Ohio State University in 1903 with a degree in Mechanical Engineering.

After 10 years' engineering and sales experience Mr. Klie in 1914 became president of Smith and

Oby Co., a firm which for forty years handled the engineering, power, piping, heating and plumbing work of many of Cleveland's large buildings.

Even with the great demands made upon his time and energy by his business Mr. Klie has served many business and trade organizations both locally and nationally. In Cleveland he was president of *Building Trades Employers Association* and the *Associated Plumbing Contractors.* He holds membership in the Cleveland Club, the Cleveland Athletic Club, Rotary Club, University Club and Delta Tau Delta fraternity as well as other fraternal organizations.

At present Mr. Klie is serving his third term as president of the *Heating and Piping Contractors Association* and previously he served two terms as president of the National Association of Building Trades Employers.

WALTER KLIE

J. H. Walker

J. H. Walker, Detroit, Mich., has devoted much time to research work since he graduated from the University of Michigan in 1911. The Dept. of Engineering Research of that institution also conferred upon him the honorary title of Research Engineer.

Mr. Walker was born in 1890 and after completing his schooling he became associated with the Detroit Edison Co., where he was closely identified with research for some years.

During the past several years Mr. Walker has been in charge of the company's district heating work and at present he is engineering assistant to the general manager.

In odd moments Mr. Walker has collaborated in the preparation of two popular text books, with the late John R. Allen, on Heating and Ventilation and with Sabin Crocker on the Piping Handbook.

Numerous papers have come from Mr. Walker's pen and they will be found in the trade publications and in the transactions of engineering and trade associations. He has served the Society as a member of its Council in 1925, and on many technical committees. In 1922 he was president of the *National District Heating Association.*

J. H. WALKER

FRANK B. ROWLEY
2nd Vice President and
Chairman, Committee on Research
(Outline of his professional career was published in the October Journal)

Of Interest to Members

Council Meeting December 2nd

The next regularly scheduled meeting of the Council of the Society will be held at the headquarters office, 51 Madison Ave., New York, 10:00 a. m. Tuesday, December 2.

Important matters of business will be brought before the meeting by Pres. L. A. Harding.

National Officers Visit Chapters

Pres. L. A. Harding visited four Chapters during the month of November in Pittsburgh, Detroit, Philadelphia and New York, where his illustrated talk on, Utilization of the Sun's Energy was enthusiastically received by large audiences. At several of the Chapter Meetings, C. W. Farrar, Treasurer of the Society, discussed the plans on the campaign to increase the Society membership and told the members where they might find suitable candidates.

F. C. Houghten, Director of the Society's Laboratory, gave a talk on, The Effect of Solar Radiation on Heating and Ventilating Problems, based upon investigations made at the Society's Laboratory in Pittsburgh. During October this same group visited the middle western Chapters at Chicago, St. Louis, Kansas City, Milwaukee and Minneapolis, while the Secretary, A. V. Hutchinson, continued from Kansas City and attended the opening meeting of the Southern California Chapter in Los Angeles and the regular monthly meeting of the Pacific Northwest Chapter in Seattle.

In addition a stop was made at San Francisco where a conference was attended by Messrs. Leland, Haley, Hunt, Cummings and Krueger.

Merger Unites 15 Firms

Negotiations have been completed for the merger of the Carrier Engineering Corp., Newark, Brunswick-Kroeschell Co., New Brunswick, N. J. and Chicago, and the York Heating and Ventilating Corp., Philadelphia, each one of the largest concerns respectively in the air conditioning, refrigerating, and unit heating and ventilating industries. Including subsidiaries, the merger will unite fifteen companies, five of them foreign, with total assets of approximately $15,000,000.

The consolidation will provide a single worldwide organization equipped to provide any desired kind of indoor atmospheric condition in homes, hotels and apartment houses, stores, theaters, office buildings and industrial plants, according to a statement of J. I. Lyle, executive vice-president of Carrier Engineering Corp.

The merger plan contemplates that the fifteen companies involved will retain separate entities under a holding company to be known as the Carrier Corp. which will conduct all research and will direct sales and engineering activities for the group. While no new financing is involved, Hemphill, Noyes & Co., are advising in the consolidation. There will be an exchange of shares, but the basis of exchange has not yet been definitely decided upon.

Carrier Engineering, June 30, reported total assets exceeding $7,000,000. Its capital structure consists of 209,763 shares of common stock, traded on the New York Curb. Including subsidiaries, the sales for the last fiscal year were approximately $10,000,000.

Brunswick-Kroeschell is capitalized at $2,514,595, consisting of 12,500 shares of 7 per cent cumulative preferred stock of $100 par value and 28,200 shares of no par common.

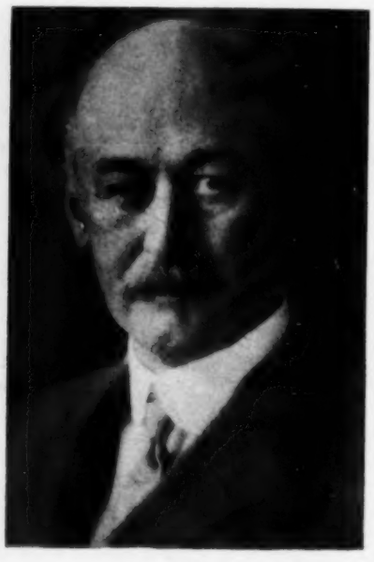
January 1, it reported total assets of $3,369,574, with sales last year of approximately $3,000,000.

York Heating and Ventilating is entirely owned by the management and employed personnel. It reported sales last year of $2,000,000.

The Carrier Engineering Corp. was founded in 1914 by Willis H. Carrier, J. I. Lyle, E. T. Murphy, and five associates who had worked with them in the Buffalo Forge Co. Mr. Carrier, who is president of the company, is a pioneer in air conditioning, and has developed a spray type of humidifier and dehumidifier, the dew-point control and recently a centrifugal system of refrigeration. He established a rational, accurate method of estimating fan system heating capacities and requirements on the Btu basis and in 1911 he presented the rational psychometric formula, from which has come the psychometric chart. Carrier systems of "manufactured weather" have been installed in the Capitol at

W. H. Carrier

J. W. Johnson



Thornton Lewis

Washington, the White House Executive Offices, and innumerable industrial plants, theaters and department stores.

The Brunswick-Kroeschell Co. is the outgrowth of the merger in 1922 of the Brunswick Refrigerating Co. of New Brunswick, N. J., the Kroeschell Brothers Co., and the Kroeschell Brothers Ice Machine Co. of Chicago. It has plants in both cities and maintains a complete line of commercial refrigerating machines for every cooling or freezing requirement. Besides a large business in institutional and industrial refrigerating installations, it does a large proportion of the marine refrigeration business in this country. It has one subsidiary, the Impex Corp. of New Brunswick, N. J. J. W. Johnson is president and Sydney B. Carpender is vice-president and general manager.

The York Heating and Ventilating Corp. is a Philadelphia concern organized in 1919, with a plant located at Bridgeport, Pa. It developed the unit system of industrial plant heating and cooling on a mass production basis, and originated the unit method of air conditioning. The company has done a great deal in research work, and it has highly organized manufacturing and sales facilities. The principal officers are Thornton Lewis, president, H. P. Gant, vice-president in charge of sales, and Donald E. French, vice-president in charge of production. Mr. Lewis was also associated with many of the Carrier executives in the Buffalo Forge Co., and later was a partner of the E. T. Murphy Co. in Philadelphia.

Messrs. Lyle, Lewis and Gant are former presidents of the American Society of Heating and Ventilating Engineers.

Heating and Piping Contractors Issue Second Edition of Standards

The second edition of Standards developed by the Committee on Standards of the *Heating and Piping Contractors National Association*, has made its appearance in loose leaf form.

The work is divided into four parts covering the following subjects: Figuring Radiation, Boiler and Radiator Loads and Ratings, Pipe Sizes for Steam and Hot Water Heating Systems and Dimensional Standards which relate to Valves and Fittings.

Included in the first section are the standard tables of heat transmission for building materials developed by the A. S. H. V. E. as well as Society's Research Laboratory data on Air Leakage and Infiltration for Various Types of Building Openings. The Pipe Size data developed by special committees of the A. S. H. V. E. and the *Heating and Piping Contractors National Association* are to be found in Section 3.

These standards show the practical application of research investigations which have been conducted by the Society's Laboratory during the past few years.

This second edition of Standards in cloth cover with ring binders is available at $5 per copy.

Standardization of Pipe Flanges and Fittings

Subcommittee No. 3 of the *American Standards Association* on Steel Pipe Flanges and Flanged Fittings of the Sectional Committee on the Standardization of Pipe Flanges and Fittings, has recently released for general distribution a proposed American standard for steel base fittings, which is now being widely distributed to industry in draft form for criticism and comment.

This proposal originated with the Manufacturers Standardization Society of the Valve and fittings industry by whom it was adopted as *standard practice* in October, 1929. This standard is not complete in itself but must be treated as a supplement to, and used in conjunction with, the American standard for steel pipe flanges and flanged fittings.

Refrigerator Safety Code Completed

The Society's representative, Lee Nusbaum, reports that the national safety code for mechanical refrigerators of all types, both domestic and commercial, has just been approved by the *American Standards Association*.

Refrigerating apparatus used in the manufacture and processing of materials such as in ice-making plants, cold storage warehouses, ice cream and dairy plants, packing houses and chemical plants, and also cooling systems of theaters and other buildings are covered in the provisions of the code, which was prepared by a technical committee of the *American Standards Association* working under the direction of the *American Society of Refrigerating Engineers*. Commercial plants of the type used in meat markets, florist shops and restaurants are also provided for.

One of the most important provisions of the code, which permits the installation of multiple systems in apartment houses with adequate safeguards to eliminate possible hazards, ends a longstanding controversy on this question. This will probably mean that regulations prohibiting the installation of multiple systems such as exist in New York City and other municipalities will not become an important factor in the refrigeration industry.

Forty-three national organizations were represented on the technical committee which has been working on the subject since 1920. These organizations are:

United States Bureau of Standards.
United States Department of Labor.
International Association of Industrial Accident Boards and Commissions.
American Institute of Refrigeration.
American Chemical Society.
American Gas Association.
American Institute of Electrical Engineers.
American Society of Civil Engineers.
American Society of Heating and Ventilating Engineers.
American Society of Mechanical Engineers.
American Warehousemen's Association.
Association of Governmental Officials in Industry.
Compressed Gas Manufacturers' Association.
Eastern Ice Association.
International Acetylene Association.
Bureau of Safe Transportation of Explosives.
National Association of Ice Industries.
National Association of Practical Refrigerating Engineers.
National Bureau of Casualty and Surety Underwriters.
National Electrical Manufacturers Association.
National Electric Light Association.
National Fire Protection Association.
National Safety Council.
New York Board of Fire Underwriters.
New York City Bureau of Fire Prevention.
Refrigerating Machinery Manufacturers Association.
Underwriters' Laboratories.

The code applies to both direct methods of refrigeration, in which the refrigerant is circulated through the system, and to the indirect, in which brine or water cooled by the refrigerant is circulated through the system.

Refrigerating systems are classed also in accordance with the amount of refrigerant used, as follows:

Class A—1,001 lbs. or more of refrigerant.
Class B—101 to 1,000 lbs., inclusive.
Class C—21 to 100 lbs., inclusive.
Class D—7 to 20 lbs., inclusive.
Class E—6 lbs. or less.

Plans Announced for Eighth Annual Oil Burner Show

Preliminary plans for the eighth annual convention and oil burner show of *The American Oil Burner Association* in the Benjamin Franklin Hotel, Philadelphia, April 13 to 18, 1931, have been announced. The annual oil burner show will be held across the street on the exhibit floor of the Gimbel Building. There will be available for exhibit purposes, 129 booths each 10 ft. by 10 ft.

The show will open Monday, April 13, at 7 P. M., and thereafter until Saturday, April 18, it will be open daily from 1:30 P. M. to 11 P. M. Exhibitors, as usual, will be manufacturers or associate members of the Association. The annual show has become the occasion for introducing new burner models and equipment improvements and information reaching the Association headquarters indicates that many new and interesting developments will be revealed at the Philadelphia exposition. It will be the second consecutive show which will be open to the general public, this plan having been followed last year with outstanding success. More than 10,000 people were registered as visitors at the 1930 show in Chicago.

Business meetings and discussions of Association members will be held during the morning at the hotel to allow for attendance at the show in the afternoon and evening.

R. B. Dickson Elected Kewanee President

At a meeting of the board of directors of the Kewanee Boiler Corp., Kewanee, Ill., held in New York City, Oct. 31, officers were elected as follows:

B. F. Baker, Chairman of the Board.
R. B. Dickson, President.
E. F. Wagner, Secretary.
Arthur Cook, Treasurer.
R. M. Powers, Assistant Secretary.
E. H. Karau, Assistant Treasurer.

Mr. Dickson, the new president, has devoted his business career to the heating industry. For many years he was a sales engineer, then became district manager for his company in Chicago and later returned to the home office as sales manager and recently his position has been vice-president in charge of sales.

Mr. Dickson, who joined the Society in 1919, has a host of friends in the industry who will extend their congratulations.

Death of John McClure Chase

John McClure Chase, vice-president of W. A. Case & Son Mfg. Co., Buffalo, N. Y., died at the New Rochelle Hospital, New Rochelle, N. Y., on October 16. He was born in Syracuse, N. Y., in 1867, where he began his career in the plumbing shop of his father, George W. Chase. Later he became associated in the wholesale supply business in Syracuse with his uncle, R. C. McClure. After a few years he went to Buffalo and obtained a position with W. A. Case & Son Mfg. Co., where he became head of the plumbing supply department. In 1900 he organized the R. C. McClure Co. at Syracuse, which was conducted until 1916 and then sold to W. A. Case & Son Mfg. Co., with which concern he again became identified, taking charge of the company's interests in New York City.

During the Spanish American War Mr. Chase joined the New York State National Guard for service in Cuba and during the World War he was interested in government war work. For a time he was connected with the McCambridge Copper Co., Philadelphia, Pa., in an official capacity.

He was a member of Syracuse Lodge 501 F. and A. M.; Syracuse Consistory A. A. S. R.; Central City Commandery Knights Templar; Lu Lu Temple A. A. O. N. M. S.; Past Monarch of Keder Khan; B. P. O. E. Lodge 31; Friars Club and the old Philadelphia Athletic Club; American Society of Heating and Ventilating Engineers, and the American Society of Sanitary Engineers.

Mr. Chase is survived by his widow and one daughter. Funeral services were held at his home in New Rochelle on Saturday, October 18, and from there his remains were taken to Syracuse where Masonic services were held at Oakwood Chapel. Interment was in Oakwood Cemetery.

Mr. Chase had been a member of the Society since 1915, and was one of the outstanding members, always interested in Society affairs. He will be missed greatly by his fellow members, who valued his friendship. The Council and Officers of the Society extend their sincerest sympathy to his widow and daughter.

Death of Michael J. Callahan

Michael J. Callahan, president of the Peerless Unit Ventilation Co., Bridgeport, Conn., and a member of the Society since 1914, died at his home in Unquowa Hill, Sunday, October 19, after an illness of several weeks' duration. Mr. Callahan was born in Ireland, July 15, 1875, and came as a boy of six years to America from Middleton, County Cork, with his parents and took up residence in New York City. Having gone through the public and high schools of New York, and with a year at Cooper Union, he found employment at the Third Avenue Railway System, and entered upon what was to be his life work, the field of heating and ventilation.

Michael J. Callahan

After completing his apprenticeship in the heating and plumbing trade, he became superintendent of many large jobs where he installed heating and power plants. At an early age, he went into business for himself in New York City, under the name of the M. J. Callahan Co. His inventive skill caused many patents in the heating and ventilating field to be issued to him. In 1915, in association with Arthur V. Dearden, he founded the Peerless Unit Ventilation Co., of which he was president at the time of his death. This company was at first located in New York City, later sought larger quarters in Long Island City, and about three and a half years ago located in Bridgeport, Conn., where it purchased a large plant.

Mr. Callahan's standing in his line was universally recognized and he was frequently called upon by various organizations to contribute technical papers. He was an indefatigable worker, and was an active member of the American Society of Heating and Ventilating Engineers, the *National Association of Fan Manufacturers* and the *Industrial Unit Heaters' Manufacturers Association.*

He made a host of friends, his social affiliations being with the Algonquin Club of Bridgeport, the Tuft Club of New York City, and the Elks.

Mr. Callahan, who was in his fifty-fifth year, is survived by his widow, three children, his father, three brothers and a sister, to whom the Officers and Council of the Society extend their most sincere sympathy.

Local Chapter Reports

Illinois

October 13, 1930. The annual meeting of the Illinois chapter, attended by 65 members and guests, was held at the Hotel Sherman, and was opened with the reading of the minutes of the last meeting.

Following the regular order of business the President asked for a report from the Tellers of Election, which was read by C. M. Baumgardner, and resulted in practically a unanimous vote for the following officers:

President, A. G. Sutcliffe.
Vice-President, J. J. Asberly.
Secretary, C. W. DaLand.
Treasurer, C. W. Johnson.
Board of Governors, H. P. Reid, R. B. Hayward and H. G. Thomas.

Pres. L. A. Harding of the Society was introduced by Dr. E. V. Hill, and the topic of President Harding's talk, Utilization of the Sun's Energy, was extremely interesting to those in attendance and brought about numerous discussions.

A talk on the Effect of Solar Radiation on Heating and Air Conditioning Problems was then given by F. C. Houghten, Director of the Society's Laboratory at Pittsburgh, who was introduced by John Howatt.

A. V. Hutchinson, secretary of the Society, and C. W. Farrar, chairman of the Committee for Increase of Membership, were also introduced. Mr. Hutchinson spoke of the Annual Meeting to be held in Pittsburgh, January 26-29, 1931, and Mr. Farrar gave a talk on the advantages of increasing the membership of the Society.

An enthusiastic vote of thanks was then extended to the guests and speakers.

After about fifteen new members were received into the membership of the Chapter the newly elected officers were escorted to the chair and introduced, after which the meeting adjourned.

Massachusetts

October 20, 1930. The Massachusetts Chapter opened the season with the October meeting, which was held at the new Edison Steam Service Station, Boston. The Chapter members, together with the Boston Real Estate Exchange, were the guests of the Boston Edison Co.

With competent guides the 150 members and guests present made a tour of inspection through the entire plant, and later enjoyed the dinner which was served on one of the upper levels of the premises.

After dinner, Pres. T. F. McCoy opened the meeting and then turned it over to D. S. Boyden of the Boston Edison Co., who acting as toastmaster, introduced I. E. Moultrop, chief engineer for the Edison Co. He welcomed the Society members and other guests, and then several of the Edison engineers spoke briefly on some phase of the distribution of steam.

No business was brought before the meeting, which was very successful from an educational and entertaining point of view.

Michigan

November 10, 1930. Sixty-five members and guests attended the November meeting of the Michigan Chapter held at the Cadillac Athletic Club.

After dinner, Pres. E. E. Dubry introduced the Secretary of the Society, A. V. Hutchinson, who gave an interesting account of his recent visit to the Chapters on the West Coast. Mr. Hutchinson also called attention to the next Annual Meeting of the Society which will be held in Pittsburgh, January 1931.

President Dubry then presented L. A. Harding, President of the Society, who delivered an illustrated lecture on the subject of Utilization of the Sun's Energy. President Harding described the types of machines originally employed for utilizing the sun's energy. He also described the various types of machines used up to the time of the recent experiments of the French scientist Claude who utilized the difference in water temperatures at the surface of the ocean water and the temperature of the water at a sufficient depth below the surface to generate power.

He also mentioned a practical method of obtaining heat from the sun by the use of so-called hot boxes placed on the roofs of buildings in such places as Florida and California. By this process, the domestic hot water is heated entirely by the sun's rays and is maintained at a temperature as high as 110 F the year round. President Harding brought out the fact that under certain conditions in the summer time, the sun's energy is equivalent to 5000 hp per acre. He predicted that weather forecasts in the future may be made by taking the readings of the solar energy.

The next speaker of the evening was F. C. Houghten, Director of the Society's Research Laboratory at Pittsburgh, whose subject, Solar Energy and Its Effect on Heating and Ventilating Problems, was of considerable interest to the air conditioning engineers. Mr. Houghten's discussion dealt with the absorption properties of the sun's energy by different thicknesses of roof slabs and the releasing of this absorbed heat during different periods of the day and night.

President Dubry then called upon the Secretary of the Chapter, E. H. Clark, to read the questions which had been sent in by the members to be discussed at the meeting. One of the questions was, What is the best method of control in a residence where the downstairs is equipped with extended-surface, copper-fin radiation and a portion of the upstairs is furnished with cast-iron radiation? In the general discussion of this question, Messrs. Whalen, Purdy, Atherton, Harms, Leuchtenberg, Cantwell and Wilde gave their interpretation of the most efficient as well as economical method of control. Perhaps no definite solution was reached but in general it was the consensus of opinion that in all probability the best method of control would be zone control. It was brought out that without zone control it would be possible to secure good results by properly manipulating the dampers on the concealed radiators.

After this discussion J. F. McIntire presented the following question: What effect is to be had on the heat emission of cast iron radiation and of concealed radiation if the relative humidity of the air in the room is increased from 20 per cent to 50 per cent? In the general discussion that followed it was the opinion that no appreciable difference was to be had in the heat emission from a cast-iron radiator under this condition whereas it was entirely possible that the heat emission from a concealed or extended surface type of radiator might be increased due to the difference in weight of the air at a relative humidity of 50 per cent as compared with a relative humidity of 20 per cent.

W. A. Rowe stated that in the future it is entirely probable that in the heating of residences an attempt would be made to heat the floor to a comfortable temperature and at the same time to maintain a temperature in the breathing zone of the room ranging from 65 F to 68 F with a resultant over-all temperature which would be more comfortable than if it is attempted to keep the temperature of the air of the breathing zone at 70 F as is common practice today.

October 13, 1930. Sixty-five members and guests attended the opening meeting of the Michigan Chapter, held at the Cadillac Athletic Club, Detroit, Mich.

Following President Dubry's introduction of the officers and members of the Committees, J. L. Fuller introduced Count Alfred Von Niezychowski, who was second officer of the German cruiser, Kronprinz, a mystery raider during the World War which captured fifteen allied vessels without the loss of a single life. His talk was full of thrills and numerous points of interest pertaining to engineering practices.

J. E. Degan then introduced George R. Thompson, Budget Director of the State of Michigan, whose subject was Budget Engineering. Mr. Thompson presented interesting data regarding the State of Michigan's building activities and brought out many interesting facts to the engineers and contractors.

H. L. Walton and E. R. Harrigan participated in an instructive discussion following Mr. Thompson's address.

The Michigan Chapter has inaugurated a policy of devoting a few minutes at the end of each meeting to a discussion of questions and problems which members of the Society may care to bring up. The plan is to have the members send their questions to the Chapter Secretary who will present them to the Board of Governors at their next meeting, and who in turn will assign some member of the organization to prepare the answers or lead a discussion concerning these questions at the following meeting of the Chapter. This Chapter feels that the meetings are a logical clearing house for questions and problems which may arise in the everyday experience of the members and it is hoped that this feature will prove to be highly valuable to all the members.

Minnesota

October 17, 1930. The first meeting of the 1930-31 season of the Minnesota Chapter was held at the Men's Union Bldg., University of Minnesota, with 65 members and guests in attendance.

After all business had been attended to, Pres. D. M. Forfar introduced the speakers of the evening, L. A. Harding, President of the Society, and F. C. Houghten, Director of the Society's Research Laboratory.

President Harding gave an interesting talk on Utilization of the Sun's Energy, while Mr. Houghten discussed the Effect of Solar Radiation on Heating and Air Conditioning Problems.

Both talks were fully illustrated with slides and were exceptionally well presented.

Following this, C. W. Farrar, Treasurer of the Society, gave a talk on the present Increase of Membership Campaign which is to be in effect from Oct. 15 to Jan. 15.

New York

October 20, 1930. James H. Scarr, Senior Meteorologist of New York City, otherwise known as the Weather Man, was the speaker at the first meeting of the 1930-31 season of the New York Chapter.

The interesting experiences related by Mr. Scarr held the undivided attention of the audience throughout his talk. He told of some of the problems with which his organization is confronted, which at first seemed to be very complicated, but which, in many cases, were solved by using a little common sense. These included the maintenance of proper humidity conditions in sugar warehouses near the meadows of New Jersey, by merely taking humidity readings inside and outside of the buildings, and opening or closing the doors and windows as the conditions require. He also told of preventing condensation and rust on tin cans transported to the Pacific Coast by the simple expedient of taking a southerly route to avoid high altitudes and the consequent low temperatures. A considerable saving in tin plated material transported by water to the Pacific Coast via the Panama Canal was also effected by comparatively simple means.

The main part of Mr. Scarr's talk was devoted to the Weather in Court, in which he related experiences showing the important part the Weather Bureau frequently plays in the settlement of law suits. He stated that his organization is subpoenaed on the average of twice a day as a witness in some kind of a legal entanglement.

The Chapter was also honored by the presence of Major Donlinson, whose duties involve the design and installation of heating and ventilating equipment of a large number of buildings used by the government, particularly for the army. Major Donlinson briefly reviewed some of his experiences.

The meeting was attended by 68 members and guests.

President Offner said that the Chapter would be honored in November by the presence of President L. A. Harding and Director F. C. Houghten of the Laboratory.

Western New York

October 13, 1930. The October meeting was held at Hotel Buffalo, Buffalo, N. Y., with 50 members and guests at the dinner, and 100 or more attending the meeting, which was presided over by Pres. F. H. Burke. All affiliated chapters of the Buffalo Engineering Society were invited as guests.

Miss Margaret Ingels, engineer of the Educational Division of the Carrier-Lyle Corp., spoke on Doing Something About the Weather, and stated that the evolution of air conditioning has reached the point where it is now regarded by the modern housewife as almost essential.

She directed attention to the fact that during the month of February, when respiratory diseases are at a maximum, the moisture in the air is at a minimum, stating that a scientific test of the air in the average American household has proved it drier than that of the Sahara Desert. The speaker added that while the American is suffering through lack of moisture to the extent of two hard colds a year, the Eskimo rarely has a cold, due to the mode of living in an igloo, the walls of which are always damp.

Miss Ingel's talk was illustrated with slides which, added greatly to its interest.

Philadelphia

October 9, 1930. The regular October meeting of the Philadelphia Chapter was held at the Engineers Club. The meeting was called to order by Pres. Harry Black, after which the minutes of the preceding meeting were read and approved.

The report of A. J. Nesbitt as Philadelphia Chapter representative on the Society's Nominating Committee was then presented.

M. F. Blankin, chairman of the Meetings Committee, announced that Pres. L. A. Harding would be the guest at the November meeting of the Chapter, and urged all members to make this an outstanding occasion.

Mr. Nesbitt, chairman of the Membership Committee, then gave a report on activities of his committee during the past four months.

J. D. Cassell was appointed chairman of a committee to meet with Hubert C. Eicher, superintendent of the State Department of Public Schools, at Harrisburg, and a similar committee to be appointed by the Pittsburgh Chapter of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, for the purpose of revising the present code covering heating and ventilating of school buildings in the State of Pennsylvania. Mr. Cassell was authorized to appoint two additional members to serve with him on this committee.

The meeting was then turned over to F. D. Mensing, who

conducted an open discussion on various problems involved in heating and ventilating work. A number of questions were asked and which served to bring out many points of interest in connection with heating and ventilating practices, both past and present.

St. Louis

October 14, 1930. The St. Louis Chapter of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS held its October meeting at the Roosevelt Hotel, and was called to order by Pres. E. A. White with 46 members and guests present.

President White read a letter from Paul Sodemann in which he expressed regret that it became necessary to resign as a member of the St. Louis Chapter and as its secretary, due to his moving out of the city. President White informed the Chapter that J. M. Foster, who had been appointed temporary secretary by the President, had acted in this capacity in the emergency, but that before the reading of the minutes of the preceding meeting it would be necessary to elect a secretary to fill the unexpired term, created by Mr. Sodemann's resignation. Nominations were called for, and C. A. Pickett moved that J. M. Foster, the temporary secretary, be elected unanimously, which met with approval.

It was announced that at the December meeting, in addition to the election of officers, T. J. Hester would present a paper on Heating Specialties.

C. A. Pickett, chairman of the entertainment committee, being called upon for a report, read a statement of the receipts and expenditures of the Golf Meet and Dinner Dance held at the North Shore Country Club, September 17. Mr. Pickett brought up the subject of holding a dinner dance some time during the fall season, and it was unanimously agreed that such a dance be held.

The Chapter on this occasion was honored by four very distinguished guests, President L. A. Harding, F. C. Houghten, Director of Research Laboratory; C. W. Farrar, Treasurer, and A. V. Hutchinson, Secretary. President Harding gave a most interesting and instructive talk on, Utilization of the Sun's Energy, which was illustrated with lantern slides. Mr. Houghten also gave a very enlightening talk on The Effect of Solar Radiation on Heating and Air Conditioning Problems; his talk was also illustrated with lantern slides. Mr. Farrar spoke on activities of the Society with special reference to the possibilities for securing new members. Mr. Hutchinson gave some very interesting information as to the procedure employed in the handling of applications, and also read figures of various accounts necessary to carry on the work of the Society.

The members expressed their appreciation of the talks given by our national officers by a rising vote of thanks.

Southern California

October 17, 1930. The Southern California Chapter held its first meeting for the year 1930-31 in October at the Engineers' Club, Los Angeles, the large attendance of members being swelled by a number of guests, including A. V. Hutchinson, Secretary of the Society.

The meeting was an enthusiastic one, with three principal speakers, the first of whom was George D. Hoffman, who recalled some of the early days in the heating practice.

R. L. Gifford gave the members of the new Chapter an interesting description of the early days of the Society.

Mr. Hutchinson then presented a very complete and comprehensive survey of the organization, detailing the manner in which the Society functions. He spoke at length, outlining the work being done by the Research Laboratory, and at the request of the members made numerous suggestions as to the future plans for the Southern California Chapter.

All the members and guests appreciated Mr. Hutchinson's visit as he added enthusiasm and incentive for the building of a strong and representative group.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the name of applicants and their references shall be printed in the next issue of the Journal of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Membership Committee as soon as possible.

When the Membership Committee has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 19 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Membership Committee, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by December 15, 1930, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
BAILEY, GEORGE B., Thermal Engrg. Co., Boston, Mass.	Alfred Abboud T. F. McCoy	Philip Barker P. H. Schoepflin
BRIGHAM, FREDERICK HUBBARD, Sales Engr., Gilbert Howe Gleason, West Medford, Mass.	C. R. Swaney Myles Standish	E. W. Smallman W. J. Ahearn

BUNKER, FRANK J., Chief Engr., Master Fan Corp., Los Angeles, Calif.	J. B. Armitage E. C. Evans	O. W. Ott A. H. Berg
CANDEE, ANDREW HALEY, General Engr., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.	M. M. Timmerman H. L. Moore	C. A. Bulkeley
COOK, CHAUNCEY JEWETT, Puro & Cook, Syracuse, N. Y.	O. E. Frank J. J. Landers	O. K. Dyer R. T. Thornton
DOCK, CHESTER JUSTIN, Uhl Co., Minneapolis, Minn.	Albert Buenger A. J. Huch	W. F. Uhl J. B. Harris
EATON, VINCENT, Consulting Engineer, 5007 Euclid Ave., Cleveland, Ohio.	H. M. Nobis F. H. Morris	W. C. Kammerer R. G. Davis
GABELMAN, HAROLD DELMAR, Student, Carnegie Institute of Technology, Pittsburgh, Pa.	S. E. Dibble S. F. Richards	
GILLIAM, OLIVER FULGHAM, York Htg. & Vtg. Corp., Chicago, Ill. (*Advancement*)	Thornton Lewis S. C. Bloom	R. R. Taliaferro J. A. Carey
HARRIS, HAROLD RUSSELL, Sales Engr., Manufacturers' Agent. Minneapolis, Minn.	Albert Buenger E. F. Jones	J. V. Martenis W. F. Uhl
HERMAN, J., JR., Estimator, J. Herman Co., Los Angeles, Calif.	O. W. Ott C. S. Anderson	A. J. Bouey P. R. Adrianse
HILL, FRED MILROY, Consulting & Supervising Engineer, Fred M. Hill, Los Angeles, Calif.	L. H. Polderman A. H. Simonds	E. H. Kendall J. S. Earhart
HODEAUX, WALTER LEWIS, Owner, W. L. Hodeaux Plbg. & Htg. Co., Palm Beach, Fla.	C. W. Stewart	C. V. Haynes
KNIBB, ALFRED EDWARD, Heating Engr., Vagg Wilson Co., Ltd., Regina, Saskatchewan, Canada.	C. D. Bushnell F. J. Firsching	G. S. McEllroy P. A. Edwards
PORTER, HERBERT MERWIN, Owner, Belden-Porter, Minneapolis, Minn.	Albert Buenger A. J. Huch	W. F. Uhl J. B. Harris
SLATER, JEAN BERT, Howard Iron Works, Buffalo, N. Y.	Joseph Davis E. E. Johnson	O. K. Dyer Gilbert Frankel
STEELE, ALFRED N., Genl. Sales Mgr., Trane Co., La Crosse, Wis.	R. N. Trane T. R. Johnson	C. J. Scanlan M. W. Miller
STEELE, HARRY G., President, U. S. Electrical Mfg. Co., Los Angeles, Calif.	Harrold English H. B. Lauer	E. H. Kendall J. S. Earhart
VOISINET, WALTER E., Manager, Buffalo Office, The Herman Nelson Corp., Buffalo, N. Y.	Joseph Davis M. C. Beman	F. H. Burke W. G. Fraser

Candidates Elected

In past issues of the Journal of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Membership Committee and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. II, Sec. VIII, of the By-Laws, the following list of candidates elected:

MEMBERS

CUSHMAN, LESTER D., Mech. Engr., James J. Ritchie & Assoc., Boston, Mass.

KEELING, HARRY BEAUFORD, American Blower Corp., Los Angeles, Calif.

LEWIS, J. CLIFFORD, President, Circulair Heat Co., Inc., Louisville, Ky.

MARTY, EDGAR O., Sherman Coal Corp., Pottsville, Pa. (*Reinstatement*)

ROHLIN, KARL W., Warren Webster & Co., Camden, N. J.

JUNIORS

CAMPBELL, E. K., JR., Thermidaire Corp., Kansas City, Mo.

GERRISH, GRENVILLE BRADBURY, Southern New England Manager, Kewanee Boiler Co., Inc., Boston, Mass.

MACKINNON, DANIEL A., Sales Engr., Johnson Service Co., New York, N. Y.

Heating · Piping and Air Conditioning EDITORIALS

Twice As Hard

While talking with an engineer connected with a large concern the other day, we asked him if he was doing much maintenance work at the present time. "No," he replied. "We have a peculiar situation in that our appropriations for maintenance work vary from month to month according to our business done that month. This is different from most industries, as it seems to me the majority of the manufacturing concerns in this country are finding this period an excellent time for getting their plants and equipment in shape for the days of one hundred per cent production around the corner. They have large cash reserves for this work, but, as I said, our appropriations depend on the month's business.

"However, that doesn't lessen my duties any; in fact it makes me work twice as hard. When we are doing a relatively small amount of maintenance and replacement work we must be extremely careful that we are attending to that which will show us the greatest return on the money invested. We must be all the more careful to pick the most efficient equipment, to cut down waste in design of piping, to make the money we have available do as big a job as possible.

"Of course, this is always important, but it is stressed particularly at this time."

The man who specifies and purchases mechanical equipment of all kinds for replacement and maintenance work must keep himself thoroughly acquainted with what the various types of such equipment can do. Important always, this is of increased importance during periods when appropriations are relatively limited due to peculiar conditions.

Valuable Information

Many piping engineers are in New York attending the National Power Show at the Grand Central Palace. Among them you will find a large percentage of the leaders of the profession.

These men have learned that it pays to keep abreast of the new developments in equipment and methods; that attendance at engineering meetings and expositions supplement admirably the regular reading of their engineering paper.

Engineering and manufacturing today are characterized by an interchange of information that has served to raise the operating standards and reduce the costs of industry. While there are many processes and methods which are, and of right should be, of a confidential nature, the general rule is to co-operate with the other fellow in the dissemination of engineering information.

Much of great practical value can be learned at the meetings of the national engineering societies and at the expositions which are frequently held in conjunction with them. If you couldn't get to the power show this year, it would seem advisable to make an effort to attend the next one.

Study Your Equipment

It is becoming more and more incumbent upon those in charge of plant management to have a periodical check-up made of all mechanical equipment, to make sure that deterioration or obsolescence are not unduly increasing production costs. New types of machines and new attachments are continually coming out which may replace or remodel present equipment at considerable net savings in operating and maintenance cost.

The kind of fuel and the fuel burning equipment should be analyzed, as this is usually responsible for a large part of the cost of plant maintenance and operation. The heat control as well as the wastage of steam should be gone into as improved temperature control, zone control or process control may be the means of effecting another very material savings in the cost of maintenance and operation.

Usually, whether it be through leaky engines, pumps, traps, etc., through poorly insulated pipes and apparatus, or through plain wastage to the atmosphere due to improper facilities for using the normal amount of surplus steam, reduction of wastage will show handsome dividends on the necessary investment in new equipment.

Air conditioning or other processing control equipment may be responsible not only for increasing production and lowering costs, but also for greatly decreasing maintenance of building and equipment where dust and dirt, warping, cracking, rusting and the temperature and moisture changes of uncontrolled atmospheric conditions and other uncontrolled process environments

cause unrecognized maintenance and upkeep costs. Increased comfort and efficiency of employes due to proper air conditions and reduced labor turnover also result in savings. Now that business is coming back and is, naturally, upon a highly competitive basis, it should be of great interest to every wide-awake executive, who intends to reap his share of this business, to see that his mechanical equipment is not imposing a cost upon production which will lose a substantial part of the profits to those who are looking after the maintenance and efficiency of their equipment properly.

Committee of Ten

It is refreshing to note concrete evidence of the realization of several representative associations in the coal and heating industries that co-operation in effort can do much to assist the consumer in making his heating equipment more effective. This committee, composed of ten of the associations interested in coal as a fuel for heating systems, is developing plans whereby stokers and other accessories to coal heating systems may be classified as to the proper grade of fuel to be used. It is also planned to grade coals on a national scale.

Co-operation of the national associations has characterized the air conditioning and heating fields for some time. It has been responsible for many of the things that have aided "man's utilization of nature's forces." Such activities deserve wide support.

To Increase Efficiency

At this time of the year occupants of too many office buildings recall the hot, sultry days of last summer with pleasure. Even the muggy weather of a few months ago is to be desired compared with the dry, dusty air characteristic of a large percentage of our offices.

For a few days in the Fall and an equally few in the Spring, the atmosphere is ideal. The entire force works at high efficiency; mistakes and lost time are at a minimum.

Such days are all too short. Summer means a big drop in work done, because of the enervating atmosphere under which we suffer. Winter means colds and coughs, lost time, uncomfortable working conditions.

It would be nothing to get excited about were it inevitable. But when modern air conditioning systems can supply the brisk, "work-and-efficiency-inducing" days of Spring and Fall (and actually show a saving in doing it) the problem is worth the consideration of every executive. Air conditioning pays big dividends —every industrial plant, every office building, hospitals, schools, public institutions of all kinds, should investigate the advantages of using air conditioning equipment.

It Will Be Done

While business has been marking time in recent months, engineering has gone right ahead. As a result, a study of almost every industry will reveal the development of new methods and practices which pressure for economy of production will soon bring into general use.

Business men who know of this engineering progress count upon it to make the approaching revival of business more than a resumption of buying. It means the reconstruction of many plants, the development of improved and new products at a lower cost. American business has always taken full advantage of new methods to scrap old ones to the gain both of producer and consumer.

Within a month, three men who are well known to and who have the confidence of a large group of engineers, have predicted for the near future revolutionary changes in piping, in heating as well as in air conditioning. A thousand-degree boiler is soon to be installed. A great extension in the use of district steam is predicted. An engineer of repute is bringing out a novel and perhaps a revolutionary method of heating. New and heretofore unheard of methods are being used in drying in industrial processes. In the maintenance of office buildings, apartments, hotels and industrial plants, new and ingenious methods are being used for effecting economy. Temperature regulation is headed toward improvements and refinements heretofore unknown.

The man who goes on record as saying a certain thing can not be done is in grave danger of living to see that very thing accomplished and being forced to reject his own statements. A classic example of this point was the mathematician who worked out formulas and published them in a book showing that it would be impossible for man to fly in a heavier-than-air machine. The ink in the book was scarcely dry before the Wright brothers made their first successful flight at Kitty Hawk. Similar cases could be cited, so instead of saying it can not be done, it is becoming increasingly popular to say, "I do not see how it can be done, but nevertheless it probably will be."

It pays for the engineer to keep his mind open, versatile and receptive to new ideas whether he be a novice or a veteran.

Effects of a Trend

A trend that has attracted more attention, perhaps, than any other engineering development has been that toward the use of higher steam pressures and temperatures. While it is unusual for this publication to call attention to specific articles in its editorials, we feel that Mr. Harman's paper, starting in this issue, on this trend, will be of considerable value to all engineers.

PRACTICAL PIPING PROBLEMS

A Sleeve for Repairing Underground Mains. Joints for Fuel Oil Lines

by **W. H. WILSON**

Sleeve for Water Mains

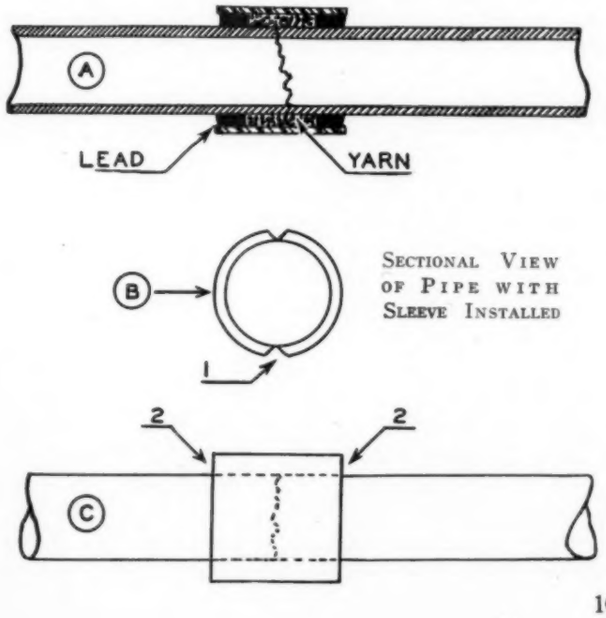
Underground water mains, when laid near railroad tracks or filled in ground, are likely to break from the pressure of surface weight that causes a shearing strain. In some cases underground obstructions are obstacles in the way of digging to expose the joints on both ends of the broken pipe, in order to replace with a length of new pipe.

The following method can be used for repairing a cast iron pipe that has been broken in this manner, when machine shop service is available and the special fittings required for this kind of work are not on hand.

Procure a piece of extra strong wrought pipe, eight to ten inches long, of a larger inside diameter than the outside diameter of the cast iron pipe. Four-inch cast iron pipe will require a 7-in. wrought pipe sleeve and a 6-in. cast iron pipe will require a 9-in. wrought pipe sleeve.

Have the machine shop split this sleeve by cutting a v-shaped groove suitable for welding on opposite sides. Place the split sleeve around the cast iron pipe over the break and secure it together with wire, temporarily, for welding. Have the sleeve welded in the v-joints and proceed to calk it in place over the break in the cast iron pipe, similar to the method of using a regular cast iron sleeve fitting.

After the joint is completed, coat the entire sleeve with asphaltum or a similar preservative coating. In case the odd sizes of wrought pipe are not available, a piece of cast iron water pipe can be used for a sleeve, having the inside diameter large enough to provide space for the lead calked joint; should there be any doubt as to a sleeve of this material breaking from the blows of the calking tools, it can be reinforced by wrought steel clamps or straps welded around the sleeve.



SECTIONAL VIEW OF PIPE WITH SLEEVE INSTALLED

In places where digging is expensive and repairs to the underground water supply is urgent, it will be to an advantage to make repairs in this manner.

The illustration shows at *A* a sectional view of the pipe with sleeve installed. *B* is an end view of the sleeve with the V cut at *1* for the welder. *C* is a view of the sleeve in place. The ends of the sleeve, shown at *2*, should have a finished cut so that the joint runner can be placed tight against the ends for pouring the lead joint.

Joints for Oil Lines

Fuel oil piping and oil piping in general presents its problems in the way of making and maintaining leak proof joints.

Box unions have been used for connecting pipes on oil lines and in a number of cases the joints have leaked, due to the unions loosening, on account of vibration and temperature changes. Manufacturers of pipe fittings supply several types of bolted unions, made of steel, some with machined or ground joint faces requiring no gasket and others of the gasket type. These unions are of heavy construction and can be made up tight, making a first class pipe joint for oil pipe lines 2 inches and smaller.

When gaskets are used in connection with unions and flanged pipe joints, the gasket should be of material that will not be affected by the oil that is being transmitted through the pipe line. Manufacturers of gaskets, when advised of the conditions, supply material that will not be affected by the oil. Metallic gaskets, for this purpose, are used particularly for the higher pressures and temperatures.

Metallic Gaskets for Oil Lines

Metallic gaskets for oil lines are made with a filling between two metallic sheets which renders the gasket flexible and the construction is such that the oil comes in contact with the metal parts of the gasket only. These gaskets are made of copper, monel, gun metal, stainless steel and other metallic substances with the interior filling of flexible material. These gaskets are used for the highest oil pressures and temperatures that are found in commercial oil refineries and oil piping installations.

Oil pipe lines of the larger sizes may have the welded joint. When using a flanged joint, the recessed type with male and female faces is often preferred, the gasket bearing on the ends of the pipe as well as the gasket contact faces of the flanges. This makes a good joint and lessens the possibility of the gasket blowing out.

Gaskets for Fuel Oil Up to 125 Lb.

The general practice in industrial plants is to use the regular standard pipe fittings for fuel oil pressure up to

125 pounds per square inch. For these threaded joints, a mixture of litharge and glycerine, mixed heavy enough to spread easily with a small brush is used on the threads before screwing them together. Another good mixture for this purpose is liquid shellac with enough lamp black added to make the mixture spread easily.

Screwed Joint Welded

In some cases, when the oil lines are subject to vibration and temperature changes of any consequence, the screwed joint is used with welding, as shown in Fig. 1. This method, while more expensive, as far as first cost is considered, makes a dependable joint for oil and suitable for any of the pressures and temperatures that are in practical use today. It is especially a good joint where the piping is subject to severe conditions.

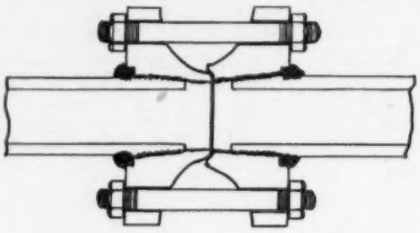


FIG. 1—FLANGED UNIONS SCREWED ON PIPE AND WELDED

Expansion

Provision for expansion must be made for oil piping as pipe work of any kind can not be installed successfully where it will be rigid and no means provided for expansion. If a straight pipe connection is made between two cylinders or other immovable parts, there must be a packed slip joint or other means of taking care of expansion and contraction.

In Fig. 1 flanged unions are screwed tight on the pipes and then welded. Manufacturers supply these unions for screwed pipe joints and when screwed on the pipe they make a strong joint that is not likely to pull apart, when subject to high pressure, vibration and severe strains. The welding in addition prevents a possible leak in the threads. It is possible for a flanged joint to be subject to strains when pulled up tight, if it is in close quarters on a short section of bent pipe, such as connections to pumps and heaters. In these cases a slight leak may develop in time.

The Bolted Flange Union

The bolted flange union makes a good joint for pipe connections when it is necessary, at times, to disconnect for repairs to the various types of machinery and equipment used in handling and transmitting oil.

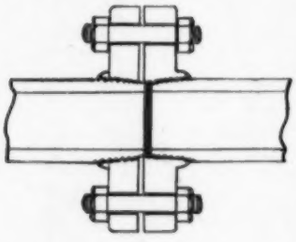


FIG. 2—GASKET BEARING ON ENDS OF PIPE

Fig. 2 shows a joint with the gasket bearing on the ends of the pipe only. This can be used when the pipe has an extra thick wall. The pipe is screwed through one of the flanges to make the male end of the joint and the pipe for the other flange is screwed into the flange, lacking enough space at the face of the flange to be slightly more than the thickness of the gasket, to make the female part of the joint.

Conventions and Expositions

American Society of Mechanical Engineers: Annual meeting, Dec. 1-5; New York City. Secretary, Calvin Rice, 33 W. 39th st., New York City.

National Power Show: Dec. 1-6; Grand Central Palace, New York City. Manager, Charles F. Roth, Grand Central Palace, New York City.

National Warm Air Heating Association: Midyear meeting, Dec. 2-3; Deshler Wallick Hotel, Columbus, O.

American Society of Refrigerating Engineers: Dec. 3-6; Hotel New Yorker, New York City. Secretary, David L. Fiske, 37 W. 39th st., New York City.

American Society of Heating and Ventilating Engineers: Annual meeting, Jan. 26-29; William Penn Hotel, Pittsburgh, Pa. Secretary, A. V. Hutchinson, 51 Madison ave., New York City.

Midwest Power Engineering Conference: Feb. 10-13; Chicago. Secretary, G. E. Pfisterer, 308 W. Washington st., Chicago.

Recent Trade Literature

Air Conditioning: The American Rolling Mill Company, Middletown, O.; eight-page, fully illustrated article on the cooling and ventilating of an auditorium in Minneapolis. Duct work is given special attention. Also a four-page bulletin giving specifications for iron plate.

Boiler Feeders: McDonnell & Miller, Wrigley Building, Chicago; four page pamphlet describing three types and telling when each should be used.

CO_2 Meters: Brown Instrument Company, Wayne and Roberts avenues, Philadelphia, Pa.; pamphlet describing an electric system of checking the CO_2 in the flue gas.

Coating Tanks: H. O. Swoboda, Inc., 3400 Forbes st., Philadelphia, Pa.; eight-page pamphlet describing large, electrically-heated coating tanks for asphalts, tars, varnishes, oils, etc. The heaters are given particular attention.

Heating and Air Conditioning Equipment: B. F. Sturtevant Company, Hyde Park, Boston, Mass.; eight-page booklet showing some of the products of this company.

Heating Systems: Texo Heater & Mfg. Corp., 220 Madison ave., Covington, Ky.; folder describing gas-fired heating cabinets for stores, offices, and homes. Forced circulation is said to give a cooling effect in summer.

Stokers: Combustion Engineering Corporation, 200 Madison ave., New York City; twenty-four page catalog showing the features of a center retort underfeed stoker in detail, listing typical installations, and describing its applications.

Unit Heaters: United States Blower and Heater Corporation, Minneapolis, Minn.; data booklet giving rating tables and construction and installation details for suspension type unit heaters for steam and hot water.

Welding Electrodes: General Electric Company Schenectady, N. Y.; booklet giving information on welding electrodes, and showing proper types for various uses.

Index to Volume II.

January-December, 1930

Heating, Piping and Air Conditioning

Air Conditioning—General

Whither Air Conditioning?, by Esten Bolling.
No. 4. April, 1930. p. 281.
What air conditioning has done for industry and human comfort; what it can do; what it will do; air conditioning in the home; abroad; applications increasing. 12 i.

"Open for Discussion."
No. 8. August, 1930. p. 671.
Comments on "Whither Air Conditioning?" (April, 1930, issue) by S. H. Harper; quartz windows in the future?

Along the Road of Controlled Indoor Atmosphere, by Perry West.
No. 4. April, 1930. p. 308.
Theory of heating standards; importance of temperature, humidity, and air motion; use of effective temperature chart; why dampness increases discomfort; comfort conditions for persons at work; for persons not engaged in manual labor; comfort chart; what is air conditioning?; theoretical standards; synthetic air chart; quality of air conditioning for various kinds of buildings; cooling; recirculation; dust; ventilation of hospitals; cubic feet of air per person per minute in various buildings. 6 i.

Controlled Indoor Atmosphere—What the Weather Can Do and What Can Be Done with the Weather, by Perry West.
No. 8. August, 1930. p. 660.
Effects of climatic zones; variations in weather give temporary relief; seasonal changes, etc.; phenomena; effect of weather on humans and industrial processing; correct atmospheric conditions; atmospheric conditions required for various industrial processes. 13 i.

The Age of Air Conditioning, by W. G. Hillen.
No. 7. July, 1930. p. 560.
We are air conscious today; eliminate windows; treating diseases; air conditioning halls, ships, mines, hotels; air conditioning homes. 5 i.

"Open for Discussion."
No. 6. June, 1930. p. 495.
A. S. H. V. E. Code of Minimum Requirements discussed by Samuel R. Lewis; installation of air washers and filters; care to prevent freezing; pumps for heating and ventilating equipment; safety arrangement for pumps feeding steam boilers.

Interviews of Interest.
No. 7. July, 1930. p. 628.
Interview with F. G. Brickwedde on use of photoelectric cell in research; operation; hook-up; calibration of thermometers. 3 i.

Interviews of Interest.
No. 11. November, 1930. p. 942.
Interview with Lyman R. Flook, supt. of construction, University of Chicago; new steam plant; metering important; conditioned air for seed study; cold rooms insulated; simulate tropic conditions. 1 i.

Control of Sound in Buildings, by F. R. Watson.
No. 12. December, 1930. p. 992.
Evil effects of noise; incorrect ideas about sound; acoustic problems in buildings; transmission of sound; mass and stiffness of walls; effect of heating and air conditioning on acoustics; control of sound in ventilation ducts; ventilation in a music building; sound controlled by long, narrow ducts; how much transmitted sound is allowable; vibrations in machinery; loudness of sound; measurement; conclusions. 7 i.

Air Conditioning—Cleaning (Including Dust and Dust Collection)

Interviews of Interest.
No. 12. December, 1930. p. 1019.
Dust recovery an engineering specialty; (interview with George A. Gieseler); characteristics of dust; pneumatic conveying; dust recovery needs research. 1 i.

Sweeping Cobwebs Out of the Sky, by Malcolm Tomlinson.
No. 12. December, 1930. p. 1012.
Need for air cleaning; air cleaned to protect quality of products; classes of dust; salt particles harm textiles and paper; dust affects weather; fumes; dust particles. 3 i.

Interviews of Interest.
No. 6. June, 1930. p. 498.
Photoelectric cell for air pollution studies in New York City; importance of data; method of obtaining; interview with James E. Ives of U. S. Public Health Service; other applications of cell. 3 i.

Industrial Plants.

Hygienic Aspects of the Industrial Dust Problem, by Philip Drinker.
No. 1. January, 1930. p. 5.
Harmful effect of dust; duty of air conditioning engineer; importance of particle size and chemical composition; three common sizes of marble dust; dust in brass foundries, spray painting, etc.; percentage of dust retained by humans; preventive measures; protective masks and respirators; objections to; settling of fumes; settlement curves for zinc oxide. 7 i.

Air Conditioning a Flour Mill, by Edgar S. Miller.
No. 2. February, 1930. p. 97.
Equipment in Acme-Evans Company plant in Indianapolis, Ind.; amount of air per barrel flour; importance of cleanliness and correct humidity; separation of impurities; effect of fluctuating effective temperature; conditions maintained at Acme-Evans plant; effective temperature the important factor. 3 i.

Dust Hazards and Profits, by H. C. Murphy.
No. 3. March, 1930. p. 196.
Keen competition necessitates reduction of industrial wastes; manufacturer of gold and silverware pays for new plant by recovering dust; a molasses air filter; $2,800 dividend on $500 investment; dust recovered from eye glass buffing machine. 3 i.

Trap Aids in Dust Removal.
No. 3. March, 1930. p. 197.
Trap used with hood to collect dust from grinding machines. 1 i.

Preventing Escape of Material in Dust Form.
No. 3. March, 1930. p. 198.
Method of filling bags and barrels which reduces waste and eliminates dust hazards. 2 i.

Interviews of Interest.
No. 5. May, 1930. p. 414.
Prevention of dusts is vital in mines; interview with Dr. R. R. Sayers, chief surgeon, Bureau of Mines; wet drilling; temperature increase in mines. 3 i.

Air Filtering for Pneumatic Coal Cleaning Plants, by Charles H. J. Patterson.
No. 6. June, 1930. p. 478.
Classification of plants requiring air conditioning of some kind; pneumatic separator for coal preparation; volume of air used; type of deck for fine coal; action of coal on filters; equipment used; capacity of units; number of tubes required; amount of surplus air necessary; size and speed of exhauster; standard units available. 5 i.

Interviews of Interest.
No. 6. June, 1930. p. 497.
Dustless removal of dust in plant of Rundle Mfg. Co. (plumbing supplies), Camden, N. J.; problem one of hygiene; silicious and iron dust; features of system; general ventilation. 1 i.

Interviews of Interest.
No. 8. August, 1930. p. 725.
Ventilation in plating processes (interview with F. Kalthoff); preventing air contamination from acid fumes in pickling process in steel company; free acid gases absorbed in special tower; ventilating tanks and piping. 1 i.

Air Conditioning a Box Shop, by R. S. Hawley.
No. 9. September, 1930. p. 760.
Plant of Consolidated Paper Co., Monroe, Mich., expanded; air conditioning system installed; humidity and dust control important; unit conditioners and unit heaters used; conditions maintained and control; location and view of units. 4 i.

Hospitals.

Curing Hay Fever with Controlled Weather, by R. F. Morrison.
No. 5. May, 1930. p. 412.
General principles; experimentation needed.

"Open for Discussion."
No. 10. October, 1930. p. 843.
Discussion on "Curing Hay Fever with Controlled Weather" (May, 1930, issue) by E. H. deConingh; use of fabric filter essential.

Air Conditioning—Cooling

Interviews of Interest.
No. 1. January, 1930. p. 88.
Architect discusses windowless buildings; interview with Robert D. Kohn.

An Air Conditioning Engineer Builds a Home, by Esten Bolling.
No. 6. June, 1930. p. 462.
Eight-room suburban home completely air conditioned; special fireplace; insulation and weather-stripping; boiler; oil burner; dampers; water heater; air conditioning system; recirculation; conditions maintained; summer and winter control and instruments; interior air circulation; auxiliary ventilation; observation facilities for research; advantages of controlled humidity; homes of the future; centralization of air conditioning. 8 i.

Uni-Power Curves and Refrigeration Calculations, by W. R. Woolrich and L. Holdredge.
No. 6. June, 1930. p. 486.
Determining theoretical work done; ton of refrigeration; refrigerating effect; heat expended in compression; coefficient of performance; adiabatic compression; amount of refrigerant per ton of refrigeration; theoretical horsepower of compression; formula for; construction and utility of unipower curves for ammonia; corrections for volumetric, mechanical, and electrical efficiency; curves and typical problems. 5 i.

Cooling with Carbon Dioxide, by A. N. Chandler.
No. 7. July, 1930. p. 572.
Carbon dioxide compressors and condensers; various types; oil separators; scale traps; receiver; pipe connections; water-cooling apparatus; lay-out of a typical system. 5 i.

Hotels.

The Thermal Load Diagram, by Herman Vetter.
No. 3. March, 1930. p. 208.
Diagram assists in designing refrigerating plants where load varies hourly; thermal load diagram for drinking water system in a hotel; diagram used for direct expansion instead of brine system; diagram for ice-making and car pre-cooling plant; computations; many other uses for this diagram (dairies, ice cream and abattoir refrigeration, etc.). 2 i.

Modern Air Conditioning Systems Increase Patronage of Older Hotels, by H. L. Branigin.
No. 9. September, 1930. *p.* 748.
Hotels gain asset with age, but must have modern equipment; Hotel Sinton, Cincinnati, installs air conditioning system; carbon dioxide compressor; main air supply; washer, etc.; temperature and humidity control; ozone machine used; recirculation. 2 i.

Industrial Plants.

Air Conditioning and Refrigerating Large Bakeries, by Walter L. Fleisher (Article No. 2).
No. 1. January, 1930. *p.* 24. (Also see Vol. I, No. 8.)
Character of doughs; calculating refrigeration requirements; maintenance of constant conditions; circulation of air; corrosion in proof boxes; cooling finished loaf; make-up department; simplification of baker's steam problem. 5 i.

Office Buildings, Theaters, Stores.

Cooling Libby, McNeill and Libby's General Offices, by Samuel R. Lewis.
No. 10. *October,* 1930. *p.* 836.
Chicago offices of packing plant air conditioned; automatic oil-type filters; exhaust fan; anemometer tests; construction of offices; introducing the air; private offices sometimes too cool; corrective heaters; broadcasting rooms; humidification; sections and plans. 8 i.

"Open for Discussion."
No. 10. *October,* 1930. *p.* 839.
Cost of heating and cooling windowless buildings, by H. L. Alt; typical office building assumed; objections to eliminating windows; steam saving; additional electric consumption; saving in radiation; saving in cooling equipment; leakage; building construction; summary. 2 i.

The Lakeside Press Air Conditioned for Comfort of Personnel, by J. H. Bailey.
No. 11. *November,* 1930. *p.* 918.
Sales and executive offices air conditioned; conditions maintained; refrigeration machine; two sets of apparatus; old stack as supply and return risers; air distribution; return ducts of tile under false flooring; placing grilles; maintaining uniform conditions; advantages obtained. 6 i.

Two-Hour Readings of Conditions Assist in Operation of Theater Air Conditioning, by Erwin L. Weber.
No. 10. *October,* 1930. *p.* 822.
Air conditioning system in Orpheum theater and office building in Seattle, Wash.; forced hot water system using converter; water temperatures; upward ventilation; cooling the air; air washer; the nozzles; air introduction; control dampers; engineer's report sheets. 3 i.

Air Conditioning Movie Theaters, by Malcolm Tomlinson.
No. 11. *November,* 1930. *p.* 934.
Air conditioning is more than cooling; theaters should provide and advertise complete air conditioning and comfortable atmospheric conditions; indoor atmosphere should be varied as outdoor atmosphere varies to eliminate shock on entering or leaving; air motion important. 2 i.

Air Conditioning a Department Store, by E. H. Dafter.
No. 2. *February,* 1930. *p.* 113.
J. L. Hudson Company, Detroit; air conditioning of main floor charged to advertising; conditions maintained; location of equipment; capacity; air distribution; automatic control; recording instruments; transformer vault air conditioning plant; dining room air conditioning; kitchen ventilation; air outlets in showcases. 7 i.

Interviews of Interest.
No. 1. *January,* 1930. *p.* 87.
Air conditioning the national capitol; interview with George W. Calver; bacterial counts; comfort conditions; early ventilation of the structure; data to be obtained.

Air Conditioning—Humidifying and Dehumidifying

Balancing Inside-Outside Conditions, by Malcolm Tomlinson.
No. 3. *March,* 1930. *p.* 220.
Balancing atmospheric conditions indoors and outdoors important; method used; charts for effective temperatures for air velocities inside and outside. 3 i.

Balancing Inside-Outside Conditions, by Malcolm Tomlinson.
No. 4. *April,* 1930. *p.* 302.
Adjustments necessary in air conditioned room or building so persons will not experience shock or discomfort on entering or leaving; formation of sensible perspiration; effective temperatures outdoors for months; effect of occupancy on optimum temperature; relation between heat loss and effective temperature; relation between heat produced and effective temperature. 3 i.

"It's Not the Heat, But the Humidity."
No. 9. *September,* 1930. *p.* 742.
Wet and dry bulb temperatures; relative humidity.

Air Conditioning and Furniture.
No. 9. *September,* 1930. *p.* 807.
Importance of air conditioning for preservation of furniture.

Hospitals.

Temperature and Humidity Control of an Oxygen Chamber, by John B. Hashagen.
No. 2. *February,* 1930. *p.* 122.
Use of oxygen as stimulant; oxygen chamber at Columbia Presbyterian Hospital, New York; brine coils; heating; control of conditions; conditions maintained. 3 i.

Air Conditioning for Diseases, by Charles Byrne.
No. 2. *February,* 1930. *p.* 120.
High blood pressure relieved by administration of oxygen; medical investigations; personal climate; radiant heat; treatment for pneumonia; air conditioning for hospitals; technique of measuring relative humidity. 2 i.

Interviews of Interest.
No. 2. *February,* 1930. *p.* 180.
Engineer and physiologist (interview with Dr. Wm. H. Howell); physiological hygiene department at Johns Hopkins; studies on climatological effects; bodily discomfort basis of bad health; the common cold; barriers to research. 1 i.

Moisture Flow Data Needed to Choose Low Humidity Equipment, by Malcolm Tomlinson.
No. 11. *November,* 1930. *p.* 922.
Low humidity enclosures in hospitals for treating diseases and in industrial plants for drying electrical equipment; no data on infiltration of moisture available; how moisture enters such rooms; makes more equipment necessary; research on problem needed.

Industrial Plants, Warehouses.

Air Conditioning Paper and Textiles, by Malcolm Tomlinson.
No. 1. *January,* 1930. *p.* 8.
Accelerated aging test; effect of sizing; cellulose acetate as heat and electric insulation; elimination of soluble salts; equilibrium curves for cotton, silk, wool, and cellulose acetate; insulation resistance of washed and unwashed silk and washed and unwashed cotton; power loss of washed and unwashed silk and cotton at various relative humidities; synthetic compounds. 3 i.

The Value of Air Conditioning for Persons Doing Physical Work in Dollars and Cents, by Malcolm Tomlinson.
No. 5. *May,* 1930. *p.* 381.
Information needed on "air comfort" and its effect on work done; zones of comfort vary; A. S. H. V. E. conducted work tests in 1926; work performed by persons under high dry bulb temperatures plotted against effective temperatures for various humidities; plotted against time; time limit for average persons performing physical work at various values of relative humidity and effective temperature; approximate value of human comfort in foot-pounds; method of computing human comfort in dollars and cents; sample problem. 9 i.

"Open for Discussion."
No. 7. *July,* 1930. *p.* 601.
Effects of air conditioning; discussion by George W. Calver on "The Value of Air Conditioning" by Malcolm Tomlinson in the May, 1930, issue; workers become acclimated to conditions.

Static Electricity in Industry, by Edgar S. Miller.
No. 6. *June,* 1930. *p.* 473.
Nature of; cause of static accumulations; avoidance of static discharges; control of absolute humidity to prevent static discharges. 1 i.

Controlled Weather Produces Quality Cigars, by Rush D. Touton.
No. 7. *July,* 1930. *p.* 547.
Effect of weather on tobacco; moisture content of leaf; regulation of air conditions is important; plant of Bayuk Cigars, Inc., Philadelphia; humidified warehouse; unit humidifiers; compressed air controls; copper fin heaters; humidity maintained; ejector system of circulation in sweat room; records kept; tobacco is fermented; 3 000,000 cu. ft. air conditioned in plants; dehumidified; centrifugal refrigeration; building insulated; air changes; central station humidifiers; storage departments; office conditioning; manufacturing processes; binder and wrapper tobaccos; optimum of humidity for rolling cigars; all departments should be air conditioned; the cafeteria. 7 i.

Humidity—Its Relation to Humanitarianism and Commercialism, by William M. Trafton.
No. 7. *July,* 1930. *p.* 583.
Effect of relative humidity on health, comfort, and efficiency; healthful conditions in textile weaving rooms; humidification for manufacturing processes; how one mill cut cost; humidifying equipment in the cloth room; fly and seconds; humidification of a cereal factory; humidifying a paper test room. 4 i.

Operating a Woolen Mill Humidifying System Correctly, by James W. Cox, Jr.
No. 8. *August,* 1930. *p.* 645.
Humidification may make difference between operating at a loss or a profit; trouble with humidifying system in a New England mill; investigation made; results; how troubles were corrected. 3 i.

"Open for Discussion."
No. 9. *September,* 1930. *p.* 772.
Discussion of "Operating a Woolen Mill Humidifying System Correctly" (August, 1930, issue) by A. W. Thompson; humidifying equipment neglected; advantages of air conditioning for cotton apparent; (more complex for wool; air conditioning prevents large losses.

Proper Placing of Humidifier Controls in Cotton Mill Card Rooms Important, by James W. Cox, Jr.
No. 11. *November,* 1930. *p.* 932.
Proper humidification determines quality of sliver to large extent; study of card rooms reveals proper methods of placing humidifiers and controls; advantages of correct installation and operation. 2 i.

"Open for Discussion."
No. 12. *December,* 1930. *p.* 1031.
Discussion by A. W. Thompson on "Proper Placing of Humidifier Controls in Cotton Mill Card Rooms Important" (November, 1930, issue); humidity regulators; lap variation; improvements in uniformity; humidified picker rooms; comparison with other departments. 1 i.

Humidity a Factor to Consider in Storage of Food Products, by Herman Vetter.
No. 8. *August,* 1930. *p.* 672.
Percentage of liquid in common foods and correct humidity for storing; a typical case with low humidity; installation with proper humidity; correcting the per cent humidity actually obtained. 2 i.

Temperature, Humidity and Air Motion Affect Apples in Storage, by Clarence E. Baker.
No. 8. *August,* 1930. *p.* 674.
Temperature most important single factor; humidity next; conditions for various kinds of apples; special equipment necessary; circulation of air; prevention of storage scald; what the air conditioning system should provide. 2 i.

Humidity in a Printing Plant.
No. 8. *August,* 1930. *p.* 682.
Advantages of controlling humidity in one printing plant.

Small Variations Allowable in Air Conditioning for Gelatin Capsule Manufacture, by William A. Hanley.
No. 10. October, 1930. *p.* 809.
Manufacturing process; sizes and wall thickness of capsules; moisture content; air conditioning plant; washer is insulated; filters; air conditioning reduces labor turn-over; importance of air conditioning. 5 i.

The Maintenance of Air Conditioning Equipment in Industrial Plants, by William A. Hanley.
No. 11. November, 1930. *p.* 905.
Advantages of proper maintenance; daily inspection routine; care of spray heads, dirt screens; cleaning intake ducts; annual overhauling; care of bearings; replace nozzle orifices; centrifugal pump; eliminators and fan runner; amount of spare parts to carry; diaphragms and gaskets; importance of air conditioning equipment. 3 i.

Some Observations on the Air Conditioning of Laundries.
No. 11. November, 1930. *p.* 982.
Air conditioning important, says Walter H. Pierce of Laundry Owners' National Association; removing excess heat; construction of building depends on climate; industrial considerations; ventilating sash and monitors; cleaning the air; relation of indoor conditions to outdoor.

Materials for Drying by Adsorption.
No. 7. July, 1930. *p.* 630.
Method; use of gels; cocoanut charcoal; adsorption capacity of charcoal.

Removing Moisture from Air by Adsorption, by Malcolm Tomlinson.
No. 9. September, 1930. *p.* 766.
Use of gels with adsorption process; typical case; performance curve for adsorption of water by a gel. 1 i.

Improved Electrical Properties by Drying, by R. F. Morrison.
No. 1. January, 1930. *p.* 40.
Practical value of the damping constant; effect of storage time on damping constant of telephone cable; effect of moisture on; regain of paper insulation; insulation resistance and humidity. 2 i.

Drying Problems in the Manufacture of Telephone Cable, by Malcolm Tomlinson.
No. 2. February, 1930. *p.* 124.
Fundamentals of drying; factors considered; extent of lead-covered cable industry; two types of telephone cable; two processes in drying loop cable; factors affecting electrical characteristics; rate of drying; drying equipment; dehumidification; the drying cycle. 2 i.

Salt Drying.
No. 5. May, 1930. *p.* 403.
General principles and methods.

Conditioned Air for Glue?, by Malcolm Tomlinson.
No. 7. July, 1930. *p.* 571.
Removal of water from glue; vapor pressure; performance curve for casein glue curds; cost of conditioned air justified? 1 i.

Drying Lime in a Wire Mill.
No. 11. November, 1930. *p.* 925.
Rods are lime coated; dried in insulated compartments with air above 212 F circulated by fans; temperatures varied by regulating steam pressure and fan speed. 1 i.

Helium as a Circulating Medium in Drying Operations.
No. 11. November, 1930. *p.* 921.
Properties of helium make it of interest as a circulating medium in drying of many substances; apparatus used; silica gel gas dryers. 1 i.

Manufacture and Proper Use of Wood Products Require Air Conditioning, by W. Le Roy Neubrech.
No. 12. December, 1930. *p.* 1026.
How wood dries; why it is dried; how it is dried; dryness of wood and humidity; air conditioning and wood; in factory; in buildings and homes; humidities in various parts of United States. 5 i.

Interviews of Interest.
No. 12. December, 1930. *p.* 1020.
A climate factory for concrete (interview with F. R. McMillan); range of tests; general laboratory of Portland Cement Association; temperature and humidity maintained; curing room; unit conditioner used; fire tests of walls. 2 i.

Office Buildings.

Air for Office Building Cleaned and Dehumidified.
No. 9. September, 1930. *p.* 731.
R. J. Reynolds Tobacco Co. building at Winston-Salem, N. C.; cast iron and brass radiation used; thermostatic controls; capacities and locations of supply and exhaust fans; intakes; filters and dehumidifiers. 1 i.

Inside Air Conditions Balanced with Outdoor Temperature, by Will H. Mayes.
No. 12. December, 1930. *p.* 1015.
Norwood office building (Austin, Tex.) air conditioned; conditions necessary; carbon dioxide compressors; refrigerant piped to units located on every other floor; outlets; recirculation; indoor temperature balanced with outdoor; temperature and humidity control; relief from asthma and hay fever. 4 i.

Schools, Colleges, Libraries.

Peak Load Must Be Considered in Design of Air Conditioning Systems, by G. L. Larson and C. Brantz.
No. 9. September, 1930. *p.* 727.
Ventilation codes are minimum requirements; many rooms contain large crowds at intervals; Great Hall in Memorial Union Building at University of Wisconsin used for dances; room cooled before arrival of crowd; heat and moisture from occupants; crowd is humidifier; test made during annual prom; air supply; complete analysis of every problem important. 3 i.

Determining Proper Air Conditions for Libraries, by R. F. Morrison.
No. 9. September, 1930. *p.* 771.
Regain of moisture curves for sheepskin, silk, ledger paper, rag paper, cotton, newspaper; conditions to maintain; advantages. 1 i.

Interviews of Interest.
No. 10. October, 1930. *p.* 889.
Interview with Ernest V. Lippe, engineer with Granger and Bollenbacher, architects; description of Morse-Ingersoll hall at Beloit College; recirculation; zone ventilation and heating; unit humidification. 1 i.

Air Conditioning—Ventilating

Decreased Death Rate of Poultry Represents Large Profit—Proper Air Conditions an Aid, by John H. Ruckman.
No. 12. December, 1930. *p.* 1008.
Importance of low operating cost; reduction in deaths means profit; ventilating the feeding battery; common type of feeding battery; relation of heating and ventilating to economy; respiration; heat loss; existing type of plant; air circulation in typical plant; conclusions. 7 i.

"Open for Discussion."
No. 1. January, 1930. *p.* 42.
Air conditioning in its relation to human welfare; comments by Major S. Munson Corbett; comments by F. C. Houghten; psychrometric chart with comfort zone. 1 i.

"Open for Discussion."
No. 2. February, 1930. *p.* 131.
Standards for air conditioning; a letter from E. W. Steel, Professor of Municipal and Sanitary Engineering; comment by S. R. Lewis; New York Commission on Ventilation studies.

Interviews of Interest.
No. 4. April, 1930. *p.* 306.
Interview with Dr. W. J. McConnell; health and air conditioning; need for adequate ventilation standard.

Testing Circulation of Air, by I. D. Mayer and C. E. Baker.
No. 5. May, 1930. *p.* 404.
Simple device may be made to produce fog; assembly of apparatus; operation; introducing the fog; finding frequency of air changes accurately; detecting leakage; numerous uses; observing heat leaks. 2 i.

Hospitals.

Interviews of Interest.
No. 2. February, 1930. *p.* 181.
Hospital engineering problems (interview with Alfred Kellogg, consulting engineer); extent of engineering problems; ventilation; zoning; electrical equipment.

Ventilating Rooms for Light Treatment.
No. 7. July, 1930. *p.* 633.
Ventilating arrangement used in Children's Preventorium at St. Paul, Minn.; diagram of air intake. 1 i.

Hotels, Apartments.

Handling Kitchen Exhaust in an Apartment House, by Samuel R. Lewis.
No. 11. November, 1930. *p.* 929.
Difficulties in handling exhausts from several kitchens; effect of wind; air an elastic substance; volume control for housed fan; risers must be tight; individual fans for each kitchen an advantage; one fan for a group of kitchens an aid; problem is important. 5 i.

Five Systems Ventilate Apartment-Museum, by Maria Sermoliño.
No. 12. December, 1930. *p.* 1007.
Master Apartment Hotel, New York, is first apartment-museum; five separate ventilation systems; air supply to auditorium; cold and hot water piping; fire protection piping; heated by vacuum system. 1 i.

Industrial Plants.

Ventilating and Heating Features of the Building Code of the Pacific Const Building Officials' Conference.
No. 1. January, 1930. *p.* 90.
General ventilating requirements; garages; dry cleaning plants; motion picture machine booths; stage ventilators.

Removal of Corrosive Fumes.
No. 2. February, 1930. *p.* 100.
Lay-out for removing nitric acid fumes from a bright dipping, stripping or plating installation. 1 i.

Office Buildings, Stores, Theaters, Churches.

Interviews of Interest.
No. 1. January, 1930. *p.* 89.
Ventilation of Federal buildings; interview with Nelson S. Thompson office of supervising architect; mechanical equipment costs in government buildings.

The Canal Bank & Trust Co. Building, New Orleans.
No. 3. March, 1930. *p.* 191.
Window-ventilated, except for vault and banking space; capacity of fans; equipment for heating and circulating ice water. 1 i.

Stopping a Fan Noise, by Louis L. Narowetz, Jr.
No. 6. June, 1930. *p.* 483.
Noise transmitted by electrical conduit; method of stopping; fan whistle; peculiar phenomena; fan tests made; noise eliminated by elliptical inlet ring. 3 i.

Industrial Trust Company Building, Providence, R. I.
No. 6. June, 1930. *p.* 545.
Size of ventilation and heating system. 1 i.

Interviews of Interest.
No. 7. July, 1930. *p.* 627.
Interview with F. X. Thale on ventilation of Hardware Mutual Insurance Co. building at Stevens Point, Wis.; air inlets at ceiling; vacuum heating system used; plan. 1 i.

Downward Ventilation in Winter, Upward in Summer, for Temple Emanu-El, Conserves Fuel, by S. P. Moore.
No. 10. October, 1930. *p.* 825.
Temple in New York City is largest edifice devoted to Jewish worship; features of building; heating; recirculating gravity indirect stacks; thermostatic regulation; boiler plant; operation of ventilation system during winter and summer months; fans used; supporting fans to isolate sound. 4 i.

Schools, Colleges.

"Open for Discussion," by S. Munson Corbett.
No. 3. March, 1930. *p.* 226.
Comments on "School Building Ventilation," by Samuel R. Lewis, published in October, 1929, issue; importance of time children spend in school on air conditioning studies; relation between air conditioning and physiological requirements.

Interviews of Interest.
No. 3. March, 1930. *p.* 278.
School room ventilation (interview with A. C. Willard); controlled ventilation necessary.

Interviews of Interest.
No. 4. April, 1930. *p.* 307.
Interview with H. W. Schmidt; school ventilation; tests made on two rooms of Wisconsin school; infiltration.

Interviews of Interest.
No. 9. September, 1930. *p.* 780.
Interview with Charles R. Ammerman; air supply for chemistry building at University of Indiana; construction of ducts. 1 i.

Heating—General

Drying and Temporary Heating of Large Buildings, by John Howatt.
No. 1. *January,* 1930. *p.* 36.
Seasonal factor in building; quick drying speeds construction; factors in drying; carbon dioxide necessary; porosity of materials; heat required; new equipment for drying; test of equipment; results; advantages of high concentration of carbon dioxide. 2 i.

Electric Air Heating, by H. L. Stiles.
No. 2. *February,* 1930. *p.* 106.
Expense involved; typical installations; radiant and convection heaters; central stations studying possibilities; seasonal load; storage heaters; off-peak power; estimating heater sizes; relative costs. 2 i.

"Open for Discussion."
No. 7. *July,* 1930. *p.* 602.
Natural gas used for heating in San Luis Obispo, Calif., instead of electricity; discussion on "Electric Air Heating," by H. L. Stiles, in February, 1930, issue, by W. D. Thurber.

Interviews of Interest.
No. 3. *March,* 1930. *p.* 278.
Heating research (interview with A. P. Kratz); actual heating effects of heating units being studied.

Open for Discussion.
No. 4. *April,* 1930. *p.* 321.
Sizing chimneys for tall buildings (also see October, 1929, issue); chart for sizing tall chimneys; sample problem checking chart. 1 i.

Heat Transfer Constants and Applications of Heat Transfer, by W. R. Woolrich and L. Holdredge.
No. 2. *February,* 1930. *p.* 127.
General applications of heat transfer; methods of heat transmission; fallacies and variables in heat data; the problem; heat requirements for incoming air; average air changes per hour for ventilation; heat requirements for heat loss; inside temperatures; heat loss through brick walls, concrete walls, stone walls, hollow tile walls, wood walls, doors and windows, roofing material, interior walls, ceilings and floors next to unheated space, and floors laid on ground; sample problem; supplementary heating; heat emission constants for heating surfaces; transmission from insulated surfaces; thickness of pipe covering to use.

Specifications for Heating and Ventilating, by Samuel R. Lewis.
No. 3. *March,* 1930. *p.* 199.
General conditions; prorating general expenses; drawings and symbols; permits; bond; insurance; extent of work; time; cleaning, protection; substitutions; guarantee; instructions and adjustments; shop drawings; temporary connections; heating during drying out; description of the plant; general construction work; grates, stokers, oil burners, etc.; boiler trimmings; hot water heater; breeching; pipe and fittings; supports; sleeves, plates, etc.; valves; traps; separators and oil filters; pumps; suction strainer; workmanship; gauges; oil tank setting; Hartford loop; vacuum traps for heavy duty. 4 i.

Specifications for Heating and Ventilating, by Samuel R. Lewis.
No. 5. *May,* 1930. *p.* 406.
Test of piping; insulation inside buildings; outside; fans; power transmission; motive power; sound proofing; convectors; direct and concealed heaters; partitions and housings; ducts, hoods, guards, dampers; registers, grilles, diffusers; ash and coal handling; thermometers and instruments; automatic control. 1 i.

"Open for Discussion."
No. 3. *March,* 1930. *p.* 226.
Comments (by S. R. Lewis) on the first three sections of the Code of Minimum Rrequirements, published by the *American Society of Heating and Ventilating Engineers;* minimum requirements for estimating heat for a building; amount of heat from steam and hot water radiators. 1 i.

"Open for Discussion."
No. 4. *April,* 1930. *p.* 324.
Discussion on Sections 4-7 of the A. S. H. V.. E. Code of Minimum Requirements, by Samuel R. Lewis; determining amount of indirect steam or hot water radiating surface; dampers and by-passes; definition of registers, grilles, etc.; notes on warm air furnace heating plants; design and installation of chimneys. 3 i.

"Open for Discussion."
No. 5. *May,* 1930. *p.* 419.
Comments on Sections 8 to 10 of the A. S. H. V. E. Code of Minimum Requirements, by Samuel R. Lewis; pipe sizes for low pressure heating systems; gravity and forced hot water heating systems; air ducts; dampers; measuring air velocities; installation of fans.

Investigation of the Heat Insulation Properties of Building Construction, by H. Krueger and A. Eriksson (reviewed by J. C. Peebles).
No. 7. *July,* 1930. *p.* 563.
Swedish investigators determine heat conductivity of concrete, frame, and brick construction and windows; two tests on cork; comparison with American methods; values obtained check A. S. H. V. E. values. 1 i.

Measurement of Air Temperatures, by Malcolm Tomlinson.
No. 9. *September,* 1930. *p.* 769.
Difficulties; effect of radiant heat; use of thermocouple; insulation of wires; surface leakage; kinds of thermocouples; accuracy. 1 i.

Suggested Reforms in Heating and Air Conditioning Nomenclature, by Samuel R. Lewis.
No. 9. *September,* 1930. *p.* 744.
Industry needs standard nomenclature; new terms suggested —elecon, elevent, fluecon, fancon, thermotrap, draft-head, direct-vent system, etc.; vacuum and vapor systems; filters; square foot and horsepower should be obsolete. 6 i.

"Open for Discussion."
No. 11. *November,* 1930. *p.* 941.
Discussion on "Suggested Reforms in Heating and Air Conditioning Nomenclature" (September, 1930, issue), by Edward B. Lewis and by Lee P. Hynes; unit of power; unit heater; convection heaters; square foot of radiation; Btu; difference between steam radiators and electric heaters; converting Btu's to kilowatts; revised nomenclature an aid.

Heating—District and Central (Including Underground Steam Piping)

Performance Data for Forty-seven University Buildings on North Carolina Campus, by I. W. Summerlin.
No. 12. *December,* 1930. *p.* 1021.
Early heating of University of North Carolina; present system; calculating heat losses; heating load on the central plant; majority of buildings heated by hot water; temperature control; underground mains; coal consumed; actual and theoretical fuel demands; power plant log; heating load curve for December, 1927; heating costs. 1927. 6 i.

First Stackless Building Erected in Chicago.
No. 1. *January,* 1930. *p.* 39.
Foreman National Bank heated from adjacent Conway Building; engineers claim no additional fuel necessary. 1 i.

Interviews of Interest.
No. 1. *January,* 1930. *p.* 88.
Central heating of government buildings; interview with George O. Vonnerta, office of the supervising architect; plants in operation in Washington, D. C.

Leak Indicators and Meters.
No. 3. *March,* 1930. *p.* 195.
Detecting leaks in underground piping; metering steam in railroad yards.

Underground Piping for District Heating, by A. A. Selike and G. D. Winans.
No. 5. *May,* 1930. *p.* 392.
Thorough study necessary; knowledge of methods of construction and installation of other utilities important; capacity of steam pipes; sample problem; graphical solution of Unwin's formula for pressure drop in pipes; piping standards of one company; detail of concrete conduit; kinds of pipe, cost per foot of conduit; service thimble; cast steel anchors; drainage; elongation of steel pipe; insulation; expansion; service piping; several factors influence transmission. 5 i.

Cell Concrete for Insulating Steam Lines, by A. G. Christie.
No. 6. *June,* 1930. *p.* 477.
Underground pipes insulated with cell concrete; method of applying; boiler breechings covered; patented process; method of mixing; weight; used as building blocks.

Sampling Pulverized Fuel.
No. 8. *August,* 1930. *p.* 648.
Method used at Trenton Channel plant.

Determining the Location of District Heating Mains, by John F. Collins, Jr.
No. 10. *October,* 1930. *p.* 817.
Necessity of careful study; municipal regulations; typical section of street; rules affecting location of mains; sidewalk vaults; minor obstructions; street crossings; preliminary office work; available data; surface survey; sub-surface survey; procedure used in Pittsburgh. 9 i.

Steam Piping for New District Heating System in Paris, by Phillippe Schereschewsky.
No. 11. *November,* 1930. *p.* 914.
Characteristics of load; location of plants; steam from electric plants; length of mains; conduits; experimental systems. 4 i.

Heating—Hot Water, Steam, Vacuum, Vapor, Unit Heaters

Fuel Consumption in Toledo Schools, by Samuel R. Lewis.
No. 12. *December,* 1930. *p.* 997.
Types of heating systems used in Toledo schools; the buildings; fuel consumed in the various types; data analyzed; advantages of steel casings around brick settings. 5 i.

Notes on Heating and Piping in Germany, by Arthur K. Ohmes.
No. 1. *January,* 1930. *p.* 30.
"Union of the Heating Industry"; heating data available; central station heating; welding pipe in small trenches. 5 i.

The Effect of Two Types of Cast-Iron Steam Radiators on Air Temperatures in Room Heating, by A. C. Willard and M. K. Fahnestock.
No. 3. *March,* 1930. *p.* 185.
Factors studied at University of Illinois in connection with steam radiators; description of rooms and radiators tested; conditions; equipment used; sample data sheet; results of investigations; conclusions; recommendations; air temperature gradients from floor to ceiling. 6 i.

Low Pressure Steam Characteristics and Steam Flow and Typical Calculations, by W. R. Woolrich and L. Holdredge.
No. 5. *May,* 1930. *p.* 397.
Total heat of steam; boiling points; temperature differences for radiators in 70 F rooms at various steam pressures; heat of liquid, latent heat, and total heat of steam; temperature differences inside and outside radiators; steam quality; specific heat of superheated steam; total heat values for different degrees of superheat at low pressures; measurements of evaporation; boiler horsepower; method of calculating; factor of evaporation chart; correcting for quality; flow of steam through pipes; formula; correction factors; graphical solution for flow; typical computations. 9 i.

Calculating Radiation Requirements, by W. R. Woolrich and L. Holdredge.
No. 4. *April,* 1930. *p.* 291.
"Rule-of-thumb" methods cause errors; heat emitted by direct radiation (steam and hot water); heat emitted by pipe and ceiling coils; rated surface of standard sizes of radiation; comparison of rules for figuring radiation; Mills' rule; modified Mills' rule; Baldwin's rule; heat balance method; comparison for northern and southern location; hot water radiation requirements; correction factors. 16 i.

"Open for Discussion."
No. 7. July, 1930. *p.* 597.
Computing radiation; discussion by G. L. Larson on "Calculating Radiation Requirements," by W. R. Woolrich and L. Holdredge in April, 1930, issue; heat from occupants; heat balance method should be used; unit of heat output; computations for field house at University of Wisconsin.

"Open for Discussion."
No. 6. June, 1930. *p.* 494.
Comments on design of radiators, by Malcolm Tomlinson; radiant and convected heat; early experiments; rating and characteristics of radiators.

How to Make Nozzle Tests of Vacuum Pumps, by S. B. Redfield.
No. 10. October, 1930. *p.* 844.
Measuring air handling capacity of vacuum pumps; low ratio nozzle tests; shape of nozzle; set up of apparatus; figuring quantity of air; results plotted; slide-rule formula; atmospheric volumetric efficiency; approximate performance determinations and their uses; rotary pumps—hurling water type. 6 i.

Hotels, Apartments.

The Beresford Apartments, New York.
No. 1. January, 1930. *p.* 32.
Heating system; expansion loops. 1 i.

Engineering Analysis Saves Over $300.00 per Day in Operating Hotel Plant, by Samuel R. Lewis.
No. 8. August, 1930. *p.* 649.
Complete analysis essential on all jobs; plant first used oil, then natural gas, then coal; section of boiler, coal bunker; generation of electricity; plan of coal conveyor. 5 i.

Mechanical Equipment of New Y. M. C. A. Building Typical of Best Practice, by Robert P. Schoenijahn.
No. 11. November, 1930. *p.* 893.
Incorporates features of a hotel, home, social center, athletic club, church, school; new Y. M. C. A. in Wilmington, Del.; two steel boilers; motor-driven, underfeed stokers; ratings and accessories; coal used; boiler room piping and return mains; steel manifolds; vacuum heating system; pumps; estimating boiler demand; heating swimming pool water; hot water generators; all steam piping standard weight steel; testing piping; dripping mains; radiation; ventilating units; heating swimming pool room; temperature control; separate exhaust system for kitchen and cafeteria; plan of boiler room. 7 i.

Industrial Plants, Terminals.

Heating and Ventilating Delray Power House 3, by Sabin Crocker.
No. 5. May, 1930. *p.* 371.
Special problems in power plant heating and ventilating; summer conditions; heated air drawn off through monitor in roof; winter conditions; installing radiation; window sweeping system to prevent condensation and frost on windows; detail of air duct and outlet at window; other methods of preventing sweating unsuccessful; auxiliary turbine room ventilation; steam requirements; general features and layout of heating system. 5 i.

Heating a Fruit Terminal Presents Unusual Problems, by C. W. DeLand.
No. 7. July, 1930. *p.* 575.
Chicago Produce Terminal and Fruit Auction; size; frequent opening of freight door and cold fruit complicates problem; estimated heating capacity required; indirect system used; fuel used 1928-29; water-logged lines; temperature records kept; layout of system. 4 i.

Unit Heaters Prevent Condensation in Dye Houses, by John R. Cooper.
No. 9. September, 1930. *p.* 767.
Preventing condensation is a problem in air transportation; necessary air changes; a typical case; location of units; another installation; recirculating damper used. 2 i.

"Open for Discussion."
No. 10. October, 1930. *p.* 843.
Discussion on "Unit Heaters Prevent Condensation in Dye Houses" (September, 1930 issue) by John R. Cooper; air directions shown incorrectly in original article.

Fern Rock Car Shops Serve Philadelphia Subway—Mechanical Equipment of Interest, by Joseph Morgan Jr.
No. 10. October, 1930. *p.* 812.
Heating inspection shop; repair shops; fans; boiler plant; ash removal; headers; incinerator; correcting draft loss in stack; calculating fan sizes; hot blast and direct radiation. 9 i.

Interviews of Interest.
No. 10. October, 1930. *p.* 889.
Interview with O. A. Anderson, chief engineer, Armour & Co.; maintenance subject to budget; trends in design of power plants; saving steam.

Air from Generators Heats Power Plant, by Thomas J. Brett.
No. 11. November, 1930. *p.* 916.
Railroad power station heated by air passing through generators; cooled in summer; lay-out; ducts used. 1 i.

Office Buildings, Churches

Mechanical Equipment of the Koppers Building, by A. R. Whaley.
No. 4. April, 1930. *p.* 299.
Description of building; direct radiation; indirect radiation, and unit heaters used; description of each; water heating; ventilation; water supply. 5 i.

Rand Tower, Minneapolis.
No. 7. July, 1930. *p.* 555.
Heating system welded; number of welds; steam supplied from half-block away; mains; overhead system used; making holes for radiator branches; keeping roof drains open with bend on roof carrying steam; expansion joint built in wall; clamp for holding pipe when tack welding. 4 i.

Vacuum System Heats Royal Insurance Building, by William S. Gaylor.
No. 8. August, 1930. *p.* 647.
Up-feed vacuum return system takes steam from district heating mains for New York City office building; piping; ventilating; air washers and filters; washer chambers of terra cotta; providing for additional ventilation. 1 i.

Direct and Indirect Heating Systems in Chicago Civic Opera, by Thomas R. Shaver.
No. 8. August, 1930. *p.* 683.
Air supply; air filtered; radiation and fans; formal and informal attire a problem; provisions for cooling; courts increase heat loss; boiler plant. 1 i.

Locomotive Smoke Removal Through High Building, by Thomas R. Shaver.
No. 9. September, 1930. *p.* 743.
Main-line railroad tracks run under Chicago Daily News building; method of removing smoke; expansion chamber; fan provided for, but not used; capacity. 1 i.

Interviews of Interest.
No. 9. September, 1930. *p.* 778.
Interview with Charles J. Lehn; index chart for steam plant operation in buildings; use of chart; gives accurate picture of proper operation. 1 i.

Practical Piping Problems, by H. L. A.
No. 2. February, 1930. *p.* 183.
Superheated hot water circulation; lay-out for supplying six buildings by forced circulation; use of injector by Russian engineers; detail of injector fittings in basement of each building. 2 i.

"Open for Discussion."
No. 9. September, 1930. *p.* 773.
Question and answer relating to "Superheated Hot Water Circulation" (February, 1930, issue) by Edward C. Caton and H. L. Alt; typical problem and solution. 1 i.

Heating and Ventilating Churches, by Samuel R. Lewis.
No. 7. July, 1930. *p.* 552.
Operation of downward indirect systems; introducing the air; simplicity and complete instructions important; automatic temperature regulation; temperature of incoming air; mixing dampers; trouble from drafts; heating and ventilating church kitchens. 8 i.

"Open for Discussion."
No. 8. August, 1930. *p.* 671.
Comments on "Heating and Ventilating Churches" (July, 1930 issue) by E. K. Campbell; church heating problem different from any other.

Mechanical Equipment of the $3,000,000 Scottish Rite Cathedral.
No. 11. November, 1930. *p.* 908.
General description of Scottish Rite Cathedral in Indianapolis, Ind.; problems; boiler plant; stokers and variable drive; stack and breechings; steam piping; vacuum system; radiation; insulation; air supply and exhaust; ducts; control of temperature and humidity; fans used; air conditioning for the pipe organ; sound isolation and absorption; air filtration and filters used; water supply and water heaters. 11 i.

Interviews of Interest.
No. 11. November, 1930. *p.* 943.
Interview with M. Ehrlich, engineer of Lake-Michigan bldg., Chicago; equipment of building; power plant records; problems of management; overheating expensive; use of records; instruction charts; costs; comparative power plant statement for Jan. to Sept., 1930.

Schools, Colleges, Hospitals

Interviews of Interest.
No. 5. May, 1930. *p.* 415.
Study of mechanical equipment in schools; interview with Dr. O. F. Ball, president of Nation's Schools Publishing Company; current trends and price indices. ... ...

After Your School Plans Are Made—It Is Worthwhile to Check and Double-check, by H. W. Schmidt.
No. 6. June, 1930. *p.* 470.
Closer co-operation between engineer and architect needed; apparatus often crowded; supervision of specialties; dangers of over-done "economy"; common troubles; too little radiation; incorrect pitch of piping; improper placing of coils; dirt pockets necessary; training of operators important. 5 i.

Temperature Distribution in Field House at University of Minnesota, by F. B. Rowley.
No. 9. September, 1930. *p.* 732.
Such structures have peculiar problems; stratification an aid; humidity; the field house; heaters; temperature control; method of making temperature distribution tests; smoke tests; results; conclusions as to correct method of regulations; plans and sections. 6 i.

Cleveland Hospital Addition. by J. Hamilton.
No. 7. July, 1930. *p.* 589.
Layout of University Hospitals group in Cleveland; new buildings; private pavilion; nurses' dormitory; mechanical problems in hospitals; changes in plans; vacuum heating system, mains welded; compressed air system; ventilation; air filtered; fan capacities; refrigeration; floor area, contents and cost of the three new buildings. 6 i.

Heating—Warm Air

Warm Air and Large Buildings, by E. K. Campbell.
No. 1. January, 1930. *p.* 12.
Importance of air movement: recirculation; installations in a church, garage, and gymnasium; largest installation (Butler Field House); cotton mill installation; effect of smouldering fire; complete test on Butler Field House. 8 i.

Design of Warm Air Fan Blast Systems for Large Structures, by Platte Overton.
No. 5. May, 1930. *p.* 386.
Unit and trunk-line systems; ductless system; typical central system; selection of ducts and outlets; detail of outlets; heater size; combustion rate; equivalent of round pipe and branches for equal friction per lineal foot; chart for resistance of air in ducts; casing-in. 4 i.

Many Applications for Direct Fired Hot Blast System in Schools, Public and Industrial Buildings, by Platte Overton.
No. 8. August, 1930. *p.* 635.
Installation in a high school; 100 per cent outside air required when building was occupied; recirculation for warming up building; humidity; velocities in ducts; operation when school is not in session; system is simple and efficient; details of dampers. 6 i.

Trunk Ducts for the Fan Blast System of Warm Air Heating, by Platte Overton.
No. 11. November, 1930. p. 923.
Construction of concrete or extended plenum system; velocities; temperature regulation; heat loss in concrete ducts; double ducts; friction loss; placing the warm air and tempered air ducts; elbows and reflectors; an individual duct system. 5 i.

Piping—General

Higher Pressures and Temperatures as They Affect the Design, Installation and Maintenance of Piping, by J. J. Harman.
No. 12. December, 1930. p. 985.
Trend of pressures and temperatures; six plants in 1200-1400 lb. range; petroleum industry; hydrogenation; the last decade; effect of high pressure on design; stress in thick walled cylinder; Clavarino's formula; Barlow's formula; curves show ratios; applying formulas to design; allowances for manufacturing limitations and wrench forces; A. S. M. E. Boiler Code formula; use modified formulas with caution; effect of high pressure on wall thickness; working pressures for ordinary metals. 7 i.

Piping—Where Reliability and Compactness Are Essential, by E. W. Sylvester.
No. 3. March, 1930. p. 192.
Piping systems in submarines; functions; considerations in design; materials used; formula for thickness of tubing; oxygen piping; ventilation pipe and ducts; valves and manifolds; flange connections; sleeve couplings; cone connections. 6 i.

The Iron and Steel Family, by Bryan T. McMinn.
No. 7. July, 1930. p. 566.
Subject of metallography of interest to piping engineers; wrought iron and steel; theory of corrosion from difference in electrolytic potentials; characteristics of steel; of cast steel; properties of steel measured by carbon content; cold-working; importance of carbon in steel; gray and white cast iron; malleablizing. 13 micrographs.

Predicting the Flow of Liquids in Pipes, by R. E. Gould.
No. 10. October, 1930. p. 850.
Method of predicting pressure loss coincident with the flow of any fluid through a pipe line; Darcy formula; Reynolds' number; variation of friction factor with Reynolds' number; circulation of water in wrought iron pipe; calcium chloride brine in wrought iron pipe; kinematic fluidity and temperature; effect of changes in temperature and specific gravity on pressure loss. 5 i.

New Alignment Chart for Computing the Pressure Drop Due to the Frictional Resistance of a Flowing Fluid, by Temple C. Patton.
No. 12. December, 1930. p. 1003.
Effect of heating and cooling in viscous region; specific gravity; velocity; diameter; viscosity; use of chart; typical problems; use of isothermal friction data; choose friction factor with care. 1 i.

Piping Requirements for Vacuum Driers, by Malcolm C. W. Tomlinson.
No. 8. August, 1930. p. 667.
Equation for radiant and convected heat; determination of constants; heat loss from cast iron radiator in a vacuum; vacuum drier test data; making the test and analyzing the data; per cent radiator output in a vacuum. 3 i.

The Accuracy of the Orifice Meter.
No. 5. May, 1930. p. 391.
Early use; skill necessary; essential to use with boilers over 200 hp.

Condenser Pumps in Duplicate, by Arthur McCutchan.
No. 6. June, 1930. p. 496.
Pumps served by common primer; can they be operated at same time or will they buck each other; pumps can be operated together. 1 i.

A Problem on Boiler Horsepower, by H. L. Alt.
No. 6. June, 1930. p. 544.
Method of heating process water to throw least load on boilers; typical calculations.

Reliable Ink Supply to Newspaper Presses Essential, by J. V. Dodge.
No. 9. September, 1930. p. 775.
Ink tanks and piping in Chicago Daily News building; forcing ink to presses; supplying kerosene and oil for cleaning and lubricating; elevations of ink, kerosene and oil tanks. 2 i.

Elaborate System of Sound Insulation in Newspaper Building.
No. 9. September, 1930. p. 765.
Insulating press-room floor to isolate sound; construction; results; special ceiling.

Practical Piping Problems, by W. H. Wilson.
No. 10. October, 1930. p. 891.
Connecting piping for conveying oxygen; valves; importance of cleaning out oil and grease; blowing out with steam. 1 i.

Chemical Piping Oxy-acetylene Welded from Sheet Aluminum.
No. 11. November, 1930. p. 904.
Technique of welding aluminum; making elbows.

Interviews of Interest.
No. 8. August, 1930. p. 725.
Fans and Pipes for Chemical Plant (interview with C. K. Clayton); chamber process used; handling acids; rubber coated fans; steel, rubber-lined tanks, pipe, valves; hard rubber piping; advantages of exchange of information.

Proper Control in Welding Pressure Vessels.
No. 1. January, 1930. p. 11.
Six factors in proper control; checking welder's ability; qualification test; test specimens. 1 i.

Selection of Material in Welding Pressure Vessels.
No. 3. March, 1930. p. 217.
Chemical composition of steel for welding; qualities. 2 i.

Welded Pressure Vessels.
No. 3. March, 1930. p. 225.
Design of shell; formula; head design. 2 i.

Piping—Air

Installation and Care of Air Piping, by A. W. Loomis.
No. 3. March, 1930. p. 203.
Cost of compressed air; intake piping; effect of intake temperature on efficiency and capacity of compressors; pulsations in conduit; material for conduit; aftercoolers; safe installation of receivers; moisture remaining in saturated air after compression; cleaning receiver and discharge pipe; discharge piping; expansion joints; piping for high air pressures; identification of pipe lines; friction of air in pipes; air filters. 5 i.

Air Piping for Signal and Other Uses in Philadelphia Subway, by Richard H. Borngesser.
No. 8. August, 1930. p. 653.
Layout and location of main air line; plan of subway; size of pipe and uses; loss of pressure; pressure requirements; installation requirements; supports and guides; service taps; expansion and contraction; bends; drainage reservoirs; anchors; sediment chambers; piping to manifold condensers; piping for compressors. 8 i.

Practical Piping Problems, by W. H. Wilson.
No. 2. February, 1930. p. 182.
Emergency repairs to compressed air line; method used. 1 i.

Practical Piping Problems, by W. H. Wilson.
No. 1. January, 1930. p. 91.
Insuring cleanliness of compressed air at Bayuk Cigar plant.

Practical Piping Problems, by W. H. Wilson.
No. 9. September, 1930. p. 806.
Pipe repairs without shutting off supply; repairs on a compressed air line; method; method applicable to other jobs. 1 i.

Practical Piping Problems, by W. H. Wilson.
No. 11. November, 1930. p. 983.
An indicator valve for underground pipe lines; installation on 100-lb. air line; making a good joint. 1 i.

Practical Piping Problems, by W. H. Wilson.
No. 1. January, 1930. p. 91.
Vacuum cleaner for railway cars made from pipe fittings. 1 i.

Piping—Hydraulic

Notes on Hydraulic Power Systems and Piping, by E. W. Sylvester.
No. 7. July, 1930. p. 579.
Advantages of hydraulic power transmission; use on shipboard; use ashore; pipe sizes; factors of safety; venting; material used for piping; joints; fittings; use of cast steel; cleanliness of system; gages; noise; hydraulic steering gear, capstan; constant displacement pump-accumulator system; sweated brass sleeve coupling; air loaded accumulator. 5 i.

Some Fundamentals of Hydraulic Piping, by Frederick G. Schranz.
No. 3. March, 1930. p. 229.
Historical notes; working pressures for pipe; laying new lines; dangers of air in high pressure lines; shocks; cooling of exhaust water; freezing.

Piping Engineers Need Information on Hydraulic Equipment, by F. G. Schranz and W. L. DeLaney.
No. 9. September, 1930. p. 776.
The hydraulic press; capacities of rams at various pressures; applications to industries. 1 i.

Practical Piping Problems, by W. H. Wilson.
No. 10. October, 1930. p. 890.
Care of hydraulic packing; keeping leathers in good condition; forms for storing leathers; use of braided flax; detail of hydraulic U leather used in connection with flax packing. 4 i.

Practical Piping Problems, by W. H. Wilson.
No. 11. November, 1930. p. 983.
Proper way to tighten bolts in flanged joints on hydraulic piping; a connection between two hydraulic cylinders. 1 i.

Piping—Oil and Gas

The Design and Installation of Insulating Oil Piping for Electrical Substations, by A. H. Beiler.
No. 8. August, 1930. p. 676.
Loss of oil's dielectric strength; purification apparatus; when installation is warranted; oil piping; properties of three oils used in transformers and circuit breakers; determination of pipe size; loss of head; rates of flow; valves and fittings; use of flexible hose; tight joints important; oil storage system; curve for friction loss in piping; variation of viscosity, specific gravity with temperature; tanks; gages; oil house construction; pumps; piping diagrams; oil hose unit; the purifier. 9 i.

Fuel Oil System for Stand-by Power Plant, by Harold K. Fox.
No. 9. September, 1930. p. 750.
San Francisco steam plant of Great Western Power company designed to give continuity of service; mechanical atomizing oil burners used; method of operation; pumps operate singly or in series; lay-out of fuel oil system. 1 i.

Practical Piping Problems, by W. H. Wilson.
No. 2. February, 1930. p. 182.
Oil heater made by welding; simple heater for cold spots in fuel oil line. 1 i.

Practical Piping Problems.
No. 4. April, 1930. p. 368.
Emergency oil feeding system made by welding from spare parts in oil refinery. 1 i.

An Industrial Gas Heating Installation, by Joseph W. Piatt.
No. 7. July, 1930. p. 587.
Equipment in Alfred Bleyer & Co. plant in Brooklyn, N. Y., manufacturer of paper bags, dishes etc.; capacity; steam pressure used; piping; boiler feed system. 4 i.

Gas Pipe Survey, by J. P. Shotland.
No. 8. August, 1930. p. 723.
Gas piping in Fein Tin Can Co.; calculation of sizes; lay-out of piping. 4 i.

Testing Pipe Joints.
No. 7. July, 1930. p. 632.
Testing joints in welded river crossing for gas line. 1 i.

Templet for Bends in Large Pipe.
No. 6. June, 1930. p. 493.
Templet made from piece of pipe for 20-in. gas line; method of using. 1 i.

Practical Piping Problems, by W. H. Wilson.
No. 12. December, 1930. p. 1073.
Joints for oil pipe lines; metallic gaskets; screwed joint welded; bolted flange union. 2 i.

Piping—Refrigeration

Piping a Refrigerated Room, by R. C. Doremus.
No. 1. January, 1930. *p.* 1.
Factors affecting the piping; three factors of heat gain; formulas for heat transfer; total heat load; calculations for a typical room; producers' and consumers' storage; classes of foods stored; pipe ratio charts for direct expansion and brine systems. 2 i.

Ammonia Pipe Sizes, by R. C. Doremus.
No. 4. April, 1930. *p.* 287.
Efficiency of refrigerating plant dependent on piping; computing surface; weight; velocity charts; maximum velocities used. 4 i.

"Open for Discussion."
No. 7. July, 1930. *p.* 601.
Flow of fluid in pipe; discussion by John C. Reed and Edgar E. Ambrosius on "Ammonia Pipe Sizes," by R. C. Doremus, in April, 1930, issue; variation of frictional resistance; relation between friction factor and Reynolds' number; University of Illinois to publish bulletin.

The Flow of Superheated Ammonia in One Inch, Extra Heavy, Black, Steel Pipe, by John C. Reed and Edgar E. Ambrosius.
No. 2. February, 1930. *p.* 101.
Tests conducted at University of Illinois; object of experiments; factors affecting flow; Reynolds' number; complete description of the test equipment; lay-out of test section; procedure; conclusions; variation of velocity with internal diameter and Reynolds' number; probable relation between friction factor and Reynolds' number of superheated ammonia; example of computing pressure drop. 10 i.

Viscosity of Refrigerants,
by John C. Reed and Edgar E. Ambrosius.
No. 6. June, 1930. *p.* 455.
Importance of viscosity; theory; units; viscosity of gases; mixed gases; viscosity of saturated ammonia; sulphur dioxide; butane; ethane; carbon dioxide; methyl chloride; ethyl chloride; air; water; curves showing variation of viscosity with temperature; tables; bibliography. 7 i.

Practical Piping Problems.
No. 4. April, 1930. *p.* 369.
Notes on ammonia piping; threads; sealing joints; soldering joints; use of red and white lead and litharge.

Low Temperature Insulation as Applied to Piping Systems, by C. T. Baker.
No. 3. March, 1930. *p.* 218.
Destructive effects of moisture; causes of air leakage; necessity for clean pipe surfaces; testing for leakage; kind of covering; importance of pipe spacing; supporting pipe lines. 4 i.

Correcting Faulty Design or Construction of Refrigerating Piping, by C. T. Baker.
No. 5. May, 1930. *p.* 376.
Waste because of faulty piping not apparent; selection of pipe and fittings; use of extra heavy pipe; choice of return bends; proper spacing to allow for air circulation essential; necessity for care in making joints; cutting pipe; use of litharge and glycerine as joint cement; flange bolts; pipe arrangement important; allowable gas velocities. 4 i.

Causes and Prevention of Corrosion in Refrigeration Piping, by J. A. Day.
No. 11. November, 1930. *p.* 926.
Factors influencing corrosion; electrolytic action; refrigeration equipment problems; use of pH method; chemical retarding agents; condenser systems; methods of preventing or retarding corrosion in brine and condenser systems; suggestions for good practice; galvanic corrosion; problems in rayon manufacture. 3 i.

A Storage Plant Refrigeration System, by E. M. Mittendorff.
No. 5. May, 1930. *p.* 390.
Egg storage room kept at 30 F and 80 per cent relative humidity; piping arrangement; removal of odors and warm air; general design of refrigeration units. 3 i.

Brine Piping and Its Installation, by Henry Torrance.
No. 7. July, 1930. *p.* 632.
Threads; red lead as lubricant; rusting up; air chambers.

Welding Galvanized Iron Pipe.
No. 5. May, 1930. *p.* 452.
Coils welded complete previous to galvanizing sometimes possible; welding galvanized iron with steel welding rod; bronze-welding galvanized iron pipe. 5 i.

Canadian Cold Storage Plant Uses Quick Freezing,
by Albert E. Macdonald.
No. 7. July, 1930. *p.* 593.
General description of Halifax Ocean Terminals; facilities offered fishing industry; power plant; fish processing; precooling facilities. 8 i.

Coolers Maintain Uniform Temperatures.
No. 12, December, 1930. *p.* 1017.
Two units in cold rooms at Bowman Dairy Co., Chicago; keep 85 tons of milk at 40 F; supplement pipe coils; automatic valve defrosts units; even temperatures maintained. 4 i.

Piping—Steam (Including Steam for Process Work)

Design

Economical Steam Pipe Sizes for Heating, Process and Power Steam, by A. W. Moulder.
No. 8. August, 1930. *p.* 639.
Method for sizing pipe a balance between the theoretical and practical; verified by usage; comparison of textbook, rule-of-thumb, and practical methods; factors to consider; tables giving pounds weight of steam carried in pipe from ¾ to 24-in. diameter for drops per foot from .0001 to .0080 lb.; the tables explained.

Economical Steam Pipe Sizes for Heating, Process and Power Steam, by A. W. Moulder.
No. 9. September, 1930. *p.* 751.
Sizing pipe for typical industrial heating system (unit heaters and radiators); lay-out; method of calculation; system explained in detail and applicable to many pipe-sizing problems; tables for pounds of steam flowing in pipe for drops per foot from .0081 to .0250 lb. 3 i.

Economical Steam Pipe Sizes for Heating, Process and Power Steam, by A. W. Moulder.
No. 10. October, 1930. *p.* 828.
Sizing piping for heating systems such as used in hotels, offices, stores, etc.; typical calculations; pounds of steam carried in pipe for drops per lineal foot of .0255 to .0800 lb.; sizing pipe for an upfeed system. 2 i.

Economical Steam Pipe Sizes for Heating Process and Power Steam, by A. W. Moulder.
No. 11. November, 1930. *p.* 898.
Conversion tables for sizing pipe for high pressure steam; example worked out in detail for a combination process and heating system; effect of insulation; fundamentals of sizing power plant piping; typical example; tables for flow of steam in pipe for drops per lineal foot of .0810 to 1.000 lb. 2 i.

The Design of Piping to Secure Flexibility,
by Arthur McCutchan.
No. 9. September, 1930. *p.* 739.
High pressures and temperatures given new interest in former "theoretical" problems of piping; thermal expansion; a boiler feed line; inlet piping to economizer; grapho-analytical method applied to heating system supply line; relations between horizontal and vertical forces; bending moments. 9 i.

Designing and Constructing Expansion Bends,
by G. W. Hauck.
No. 7. July, 1930. *p.* 557.
Uses of bends; factors to consider; amount of expansion; types of bends; type to use; installing bends for a high pressure steel pipe header; 600-ft. steel pipe line; a two-boiler job; expansion cared for by bends; drips and drains; location of anchors; lengths of pipe available for bends. 5 i.

"Open for Discussion."
No. 11. November, 1930. *p.* 937.
Discussion on "Designing and Constructing Expansion Bends" (July, 1930, issue) by Sabin Crocker; expansion of U bends; coefficient of expansion for steel pipe; expansion values of bends; thrust at anchor points; cold springing; effect of pipe wall thickness; flattening of circular cross-section of curved pipe; end connections; relation between deflection and reacting force for expansion bend; change in modulus of elasticity with temperature; bending moment at joints. 4 i.

Factors Affecting Trap Capacity, by T. H. Rea.
No. 1. January, 1930. *p.* 33.
Flow through straight-edge orifice; discharge through an orifice; effect of flash steam; two classes of trap installations; pipe connections to traps; importance of selecting traps on a pounds per minute basis; receiver separator with trap. 2 i.

Drips and Drains, by G. W. Hauck.
No. 4. April, 1930. *p.* 305.
Drains and drips for power plant piping important; draining steam line to auxiliaries; draining headers; tapping gate valves; size of drip pockets; welded drip pockets. 5 i.

Pressure Reducing Valves, by Sabin Crocker.
No. 1. January, 1930. *p.* 20.
(Also see p. 416, May, 1930 issue.)
Principles of operation; direct acting pressure regulator; pilot operated pressure regulator; service pressure range of; selection of proper size regulator; capacity of pressure regulators; method of computing discharge capacity; care required in selecting regulators; pressure reducing station with two regulators in parallel. 4 i.

"Open for Discussion."
No. 5. May, 1930. *p.* 416.
Sizing pressure regulators (discussion on "Pressure Reducing Valves, p. 20, January, 1930 issue); comparison of safety valves and pressure reducing valves; velocities in each; method of computing lift, etc.

"Open for Discussion."
No. 12. December, 1930. *p.* 1033.
Discussion on "Pressure Reducing Valves" (January, 1930, issue), by H. Marcq; variations in reduced pressure; valve lift; information necesary about valve; admissible variation; characteristics inherent to other modulating devices.

A Brief Review of Pipe Standardization.
No. 12. December, 1930. *p.* 1030.
Standards prior to 1920; sectional committee; subcommittees; purpose of American Standards Association; standardization on national scale.

Installation, Inspection, Maintenance

An Easily-Made Pipe Bender.
No. 1. January, 1930. *p.* 89.
Emergency method of bending two-inch pipe; machine made of fittings around plant. 4 i.

How to Weld Wrought Iron Pipe.
No. 4. April, 1930. *p.* 317.
Properties of wrought iron; method of welding.

Practical Piping Problems, by W. H. Wilson.
No. 1. January, 1930. *p.* 91.
Steam heating coil connections without steam trap or return line. 1 i.

Heat Balance and Toasting "Luckies"—With a Description of the Piping, by A. W. Moulder.
No. 2. February, 1930. *p.* 93.
Method of obtaining heat balance; piping for high pressures and temperatures; description of American Tobacco Co. plant; nozzle construction in 12-in. header; adjusting header assembly vertically. 6 i.

Piping for Economy and Service, by B. M. Conaty.
No. 2. February, 1930. *p.* 119.
Plant expansion of Shawinigan Chemicals, Ltd.; 3,500 ft. high pressure welded steam line; steel structures, supports, etc., made on the job; test of line. 2 i.

Cooler-Humidifier for Producer Gas, by Linn B. Bowman.
No. 3. March, 1930. *p.* 215.
Simple means devised to transfer sensible heat in producer gas to primary air blast, using the steam generated in prime movers; construction and operating details; test of; corrosion. 1 i.

Practical Piping Problems, by W. H. Wilson.
No. 2. February, 1930. *p.* 182.
Installing branch connection to steam line; method used necessitates minimum time of shut-down. 1 i.

Steam, Water, Air and Oil Piping for Railroad Yards.
No. 3. March, 1930. p. 210.
Piping requirements in railroad yards; supporting lines; draining underground piping; securing water pipe in concrete pit; joints in cast-iron conduit; expansion and contraction; table for expansion of pipe; air-operated car retarders; frost protection of water lines; snow melting coils; corrosion in nipples; valves. 16 i.
Practical Piping Problems, by W. H. Wilson.
No. 3. March, 1930. p. 279.
Drip for boiler feed line; useful when repair work is being done. 1 i.
High Pressure Fittings Inspected with Transportable X-Ray Equipment, by Ancel St. John and Herbert R. Isenburger.
No. 5. May, 1930. p. 410.
Castings inspected on jobs; apparatus used; time for inspection; what the tests show; correcting defects; principal undesirable conditions. 4 i.
Practical Piping Problems, by W. H. Wilson.
No. 6. June, 1930. p. 543.
Controlling supply to long steam line; piping; method of operation. 1 i.
Steam Header Connections.
No. 7. July, 1930. p. 577.
Arrangement of reducing valves delivering steam to 12 in. heating main in building of Chicago Produce Co. 1 i.
How to Pipe a Steam Kettle to Prevent Air-Binding, by E. M. Mittendorff.
No. 8. August, 1930. p. 666.
Diagram for piping steam jacketed kettle; sudden inlet of steam will not cause hammering. 1 i.
Repairing an Air-Bound Drying Table, by E. M. Mittendorff.
No. 11. November, 1930. p. 936.
Steam table for drying asphalt paper air-bound; symptoms; method of correcting. 1 i.
Temperature Control on Paraffine Paper Machines, by E. M. Mittendorff.
No. 5. May, 1930. p. 402.
Keeping paraffine bath at certain temperature; addition of paraffine melting tank cut down consumption and number of operators; lay-out. 1 i.
Practical Piping Problems, by W. H. Wilson.
No. 8. August, 1930. p. 722.
Many economies through proper installation of piping in industrial plants; some losses; preventing losses through traps; leaking boiler blow-off valves; waste in feedwater heater; drip valves for pumps and engines. 1 i.
Practical Piping Problems, by W. H. Wilson.
No. 9. September, 1930. p. 805.
Replacing gaskets; cleanliness of faces important; tightening bolts; piping must be installed properly; facing flanged joint of screwed type. 1 i.
Piping to Heat High Viscosity Oil for Gas Manufacture with Exhaust Steam, by Harry E. Hodgson.
No. 11. November, 1930. p. 917.
Heating device outside storage tanks heats oil; pump regulates flow; capacity and temperatures; lay-out of system; advantages. 2 i.
Trap Installation for Process Work, by T. H. Rea.
No. 2. February, 1930. p. 108.
Batch and continuous process heating; high and low pressure traps on same job; continuous process work; four general types; draining cylinder driers; multi-unit heaters; trap size required; steam condensed per ft. of bare pipe; condensation from submerged steam coils; draining jacketed kettles; six-roll flat work ironer; continuous and header coils; pressure and condensate variation in batch process work. 12 i.
"Open for Discussion."
No. 6. June, 1930. p. 494.
Demand for steam with jacketed kettles; air handling capacity of trap important. (Also see "Trap Installation for Process Work," p. 108, February, 1930 issue.)
Trap Installation and Operation, by T. H. Rea.
No. 3. March, 1930. p. 223.
Preventing steam binding; gravity drainage not imperative; accessibility of traps; bypasses; test cocks; testing traps; condensation of steam in traps; use of check valves; dirt in traps; dirt pocket. 5 i.
Steam Trap Prevents Valve Trouble.
No. 3. March, 1930. p. 207.
Drain pocket and trap placed ahead of stop valve supplying steam to reducing valve; reducing pressure by stages.
Trap Troubles, by T. H. Rea.
No. 4. April, 1930. p. 318.
Common troubles and remedies; pressure too high; no water coming to trap; trap may be filled with dirt; trap may be air-bound; mechanical condition of trap; trap may be too small; dirt or scale may prevent trap from closing; bucket-drained cylinder; loss of prime through sudden pressure drop. 3 i.
Steam Trap Records Pave Way to Savings, by T. H. Rea.
No. 6. June, 1930. p. 475.
Records of equipment essential to economies; system applicable to all steam equipment; trap card; repair parts card; use of records; inspection and repairs; charges to each trap; prorating inspection time; instances of savings made. 4 i.
Practical Piping Problems, by W. H. Wilson.
No. 4. April, 1930. p. 368.
Location of steam supply valve for high steam pipe coils; eliminates use of ladder. 1 i.
Practical Piping Problems, by W. H. Wilson.
No. 5. May, 1930. p. 453.
Indicators for valves made from spare parts; indicators necessary for proper operation; operating valve two hundred feet from hand-wheel. 2 i.

Piping—Water

Condensate from Heating System Used as Hot Water Supply for Building, by R. M. McQuitty.
No. 9. September, 1930. p. 762.
Building heated by district steam uses condensate; test installation made in St. Louis office building of Union Electric Light & Power Co.; design of system; temperatures maintained; savings; applications to various types of buildings; diagrams of systems for forced circulation and for building having no cold water house tank; estimating savings; condensate should be utilized with some system. 4 i.
"Open for Discussion."
No. 12. December, 1930. p. 1034.
Discussion by Edward Y. Dow on "Condensate from Heating System Used as Hot Water Supply for Building" (September, 1930, issue); installation in Hotel Pontchartrain, Detroit; supplied drinking water, restaurant and laundry; correction in formula in original article; condensate for making ice; filters; testing for corrosion.
Practical Piping Problems, by W. H. Wilson.
No. 3. March, 1930. p. 279.
Strainers for water supply lines; installation; cleaning. 1 i.
Practical Piping Problems, by W. H. Wilson.
No. 7. July, 1930. p. 631.
Cross-connections for sprinkler system; emergency water connection to boilers; blowing out hydraulic pipe lines. 2 i.
Practical Piping Problems, by W. H. Wilson.
No. 12. December, 1930. p. 1073.
Sleeve for repairing water mains; method of repairing underground water mains. 1 i.
Figuring Pressure and Temperature Drop in a Hot Water Piping System, by P. M. Greenwell.
No. 12. December, 1930. p. 1001.
How to figure temperature drop in a 500-ft. hot water line for a hospital; effect of insulation; size of pipe; choosing economical size pump. 3 i.

Interviews on General Topics

"Open for Discussion."
No. 8. August, 1930. p. 670.
Discussion of editorial "Elimination of Waste Campaign" (July, 1930 issue), by Samuel R. Lewis; use of electric heating; economy in piping; installing ducts; fans.
"Open for Discussion."
No. 8. August, 1930. p. 671.
Comments on editorial "The Association for Correlating Thermal Research" (May, 1930 issue), by John Howatt; value of Association.
"Open for Discussion."
No. 10. October, 1930. p. 843.
Discussion on editorial "Pooling of Information" (September, 1930 issue), by A. G. Christie; importance of group knowledge in power industry.
Interviews of Interest.
No. 7. July, 1930. p. 627.
Interview with Dr. Mortimer E. Cooley, 1930 recipient of Washington award, on engineering backgrounds; Chicago Museum of Science and Industry; early texts used by heating engineers.
Interviews of Interest.
No. 5. May, 1930. p. 415.
Chicago Museum of Science and Industry to achieve engineering perspectives; object; committee appointed by American Engineering Council.

Journal of the American Society of Heating and Ventilating Engineers

January-December, 1930—Vol. 2, Nos. 1-12

AIR CLEANING DEVICES, REPORT OF TECHNICAL ADVISORY COMMITTEE ON, Mar. 242

AIR CONDITIONING FOR RAILWAY CARS.
A. H. Candee, Dec. 1037
Extent of Air Conditioning Field for Railway Cars, Amount of Air Required, Location of Heating and Cooling Units, Method of Cooling.

AIR CONDITIONING FOR SUMMER AND WINTER COMFORT.
W. H. Carrier, Sept. 783
The Human Power Plant, Human Cooling Tower, Regulating Body Heat Losses, Ventilation Research, Synthetic Air Chart, Economic Aspects of Air Conditioning.

AIR INFILTRATION THROUGH TYPES OF WOOD FRAME CONSTRUCTION.
G. L. Larson, D. W. Nelson and C. Braatz, June 509
Cooperative Research Paper, Description of Test Apparatus and Panel Frames, Test Procedure, Discussion of Results, Effect of Painting, Plaster and Sheathing Paper.

AIR LEAKAGE THROUGH VARIOUS FORMS OF BUILDING CONSTRUCTION.
F. C. Houghten, Carl Gutberlet and C. A. Herbert, Dec. ..1044
Results of Tests; Leakage Through Cracks Between Plaster and Wood Frames; Brick Veneer Hollow Tile Wall.

Algren, A. B., Surface Conductances as Affected by Air Velocity, Temperature and Character of Surface, June .. 501

AMENDMENTS TO BY-LAWS, Jan. 66

AMENDMENTS TO THE BY-LAWS, Mar. 262

AMERICAN GAS ASSOCIATION OFFERS AWARD, NOV. 974

AMERICAN GAS ASSOCIATION TO ESTABLISH TESTING STATION ON PACIFIC COAST, NOV. 979

AMERICAN OIL BURNER ASSOCIATION ELECTS PRESIDENT, May 447

AMERICAN SOCIETY OF MECHANICAL ENGINEERS ANNIVERSARY CELEBRATION, Mar. 263

AMERICAN SOCIETY OF MECHANICAL ENGINEERS FIFTY YEARS OLD, May 443

AN AUTOMATIC SYSTEM OF HOT WATER HEATING AND HOT WATER SUPPLY.
E. L. WEBER, Dec. ... 1053
Description of Automatic System, Effect of Outdoor Temperature, Operation During Summer, Pump and Diaphragm Valve.

Annual Meeting (36th), Philadelphia, Jan. 28-31, 1930.
Invitation to the Ladies, Jan. ... 68
Railroad Certificates, Jan. ... 71
Program, Jan. ... 72
Philadelphia Ready to Entertain, Jan. ... 70
Report of, March ... 233
Entertainment, March ... 264
Past-President's Dinner, May ... 447

Annual Meeting (37th), Pittsburgh, Jan. 26-29, 1931.
Arrangements for, Sept. ... 800
Plans for, Nov. ... 975

APPLICATION OF AIR CONDITIONING TO PREMATURE NURSERIES IN HOSPITALS.
C. P. Yaglou, Philip Drinker and K. D. Blackfan, July ... 605
Nature of Problem, Methods of Controlling Body Temperature, Air Conditioning Requirements, Operation of Apparatus, Cost Data.

APPLICATION OF HEATING AND VENTILATING RESEARCH.
L. A. Harding, Sept. ... 788
Heat Transmission, New Standards, Sun Effect on Buildings, Effective Heat Output of Radiators, Panel Warming, Extended Surface Radiators, Comfort and Health.

Aston, James, Honored, Mar. ... 273
Blackfan, K. D., Application of Air Conditioning to Premature Nurseries in Hospitals, July ... 605
Blackshaw, J. L., Surface Conductances as Affected by Air Velocity, Temperature and Character of Surface, June ... 501
BOILER RATING CODE ADOPTED AS SOCIETY STANDARD, May ... 428
Revision of, Mar. ... 255
BOILER SCALE INVESTIGATION, June ... 526
Braatz, C., Air Infiltration Through Various Types of Wood Frame Construction, June ... 509
Bronson, C. E., Rating of Heating Boilers by Their Physical Characteristics, Jan. ... 54
BROOKLYN POLYTECHNIC ANNIVERSARY DINNER, June ... 508
Brown, A. I., Tests of Disc and Propeller Fans, Feb. ... 157
Buenger, Albert, Heads St. Paul Engineers, Mar. ... 270
BURNING OF SMALL PARTICLES OF CARBON, June ... 508
BY-PRODUCT COKING, Sept. ... 798
Candee, A. H., Air Conditioning for Railway Cars, Dec. ... 1037

CANDIDATES ELECTED, Jan. ... 84
Feb. ... 177
March ... 276
Apr. ... 358
May ... 449
June ... 540
July ... 624
Aug. ... 719
Sept. ... 802
Oct. ... 885
Nov. ... 980
Dec. ... 1070

CANDIDATES FOR MEMBERSHIP, Jan. ... 81
Feb. ... 175
March ... 274
Apr. ... 357
May ... 448
June ... 539
July ... 623
Aug. ... 718
Sept. ... 801
Oct. ... 885
Nov. ... 979
Dec. ... 1069

CAPACITY OF DRY RETURN MAINS FOR STEAM AND VAPOR HEATING SYSTEMS.
F. C. Houghten and Carl Gutberlet, Aug. ... 687
Laboratory Paper, Test Set-Up and Operation, Experimental Results, Practical Application of Data.

CAPACITY OF RETURN RISERS FOR STEAM AND VAPOR HEATING SYSTEMS.
F. C. Houghten and Carl Gutberlet, Oct. ... 859
Laboratory Paper, Test Set-Up and Operation, Experimental Results, Application of Data in Sizing Return Risers, Summary and Conclusions.

CARBON MONOXIDE CONCENTRATION IN GARAGES.
A. S. Langsdorf and R. R. Tucker, Aug. ... 695
Co-operative Research Paper, Description of Study Made, Concentration of Carbon Monoxide.

Carrier, W. H., Air Conditioning for Summer and Winter Comfort, Sept. ... 783

CENTRIFUGAL FANS.
G. S. Wilson, Sept. ... 797
Historical Sketch, Operating Characteristics of Centrifugal Fans, Test Equipment for Fans, Operating Characteristics of Centrifugal Fans.

CHAPTER REPORTS, Jan. ... 77
Feb. ... 173
Mar. ... 271
Apr. ... 355
May ... 444
June ... 535
July ... 622
Aug. ... 716
Oct. ... 882
Nov. ... 977
Dec. ... 1067

CHART FOR ESTIMATING INFILTRATION HEAT LOSS.
Paul D. Close, Nov. ... 956
Heat Required for Infiltration and Formula and Chart for Estimating Btu per Hour Required to Raise Entering Air to Inside Temperature.

Close, Paul D., Chart for Estimating Infiltration Heat Loss, Nov. ... 956
Close, Paul D., Heat Transfer Through Air Spaces, Oct. ... 875
Close, Paul D., How Comfort Is Affected by Surface Temperatures and Insulation, Sept. ... 792

CODES.
Boiler Rating, Mar. ... 255
Unit Heater, Apr. ... 341

COMMENTS ON DESIGN AND RATING OF DIRECT RADIATION.
Konrad Meier, Feb. ... 164
Diverging Tendencies of Designer and Engineer, Variability of So-Called Square Foot of Radiation, Heating Effect Method of Rating Radiation.

Committee on Research, Report of, Mar. ... 241
COMMITTEE ON WATER HEATING ORGANIZES, May ... 241
CONTRIBUTIONS TO A. S. H. V. E. RESEARCH FUND IN 1929, Mar. ... 242

CONTROL EQUIPMENT FOR GAS BURNER HEATING APPLIANCES.
W. E. Stark, July ... 617
Automatic Heat, Controlling and Actuating Means, Appliance and System Performance as Affected by Controls.

COUNCIL MEETING IN BUFFALO, Sept. ... 799
COUNCIL MEETS AT NEW SOCIETY HEADQUARTERS, May ... 447
COUNCIL MEMBERS AND OFFICERS, Apr. ... 349
Davies, Lynn E., The Measurement of the Flow of Air Through Registers and Grilles, Jan. ... 57
Davis, A. C., Development of the Ventilation System of the Holland Tunnel, Oct. ... 866

DEATHS.
Adams, Henry, Jan. ... 80
Allan, C. D., Apr. ... 356
Bradley, J. T., Aug. ... 717
Callahan, T. H., Dec. ... 1066
Chapman, D. W., Oct. ... 884
Dix, H. M., Nov. ... 974
Foxter, W. M., June ... 538
Grassler, Edward, Jan. ... 76
Kastello, August, Jan. ... 76
Lockwood, E. H., June ... 538
McLelland, H. B., Mar. ... 273
Mason, J. J., Aug. ... 717
Morris, J. B., Aug. ... 717
Muth, Herbert, June ... 538
Parter, S. C., Aug. ... 717
Roberts, J. H., May ... 446
Snow, W. G., May ... 446
Walker, J. B., Apr. ... 356

DEVELOPMENT OF A METHOD FOR HEAT REGULATION.
F. I. Raymond and R. D. Lambert, Apr. ... 329
Control of Temperature in Steam Heated Buildings, Eliminating Over-Shooting and Lag, Two-Temperature Control, Fractional Heating of Radiators.

DEVELOPMENT OF THE VENTILATION SYSTEM OF THE HOLLAND TUNNEL.
A. C. Davis, Oct. ... 866
Exhaust Gases from Automobile Engines, Effect of Automobile Exhaust Gases on Animal Life, Dilution of Exhaust Gases Necessary, System of Ventilation Best Adapted, Power Required to Ventilate Tunnel, Operation and Characteristics of System.

Drinker, Philip, Application of Air Conditioning to Premature Nurseries in Hospitals, July ... 605
Duffield, T. J., Appointed Executive Secretary, Research Committee, Mar. ... 272

ECONOMIC USE OF STEAM IN MODERN BUILDINGS.
F. A. Gunther, June ... 527
Distribution of Heat Within Room, Supply of Air, Regulation of Temperatures, Steam Consumption, Heating Rate.

EFFECT OF OIL BURNER ADJUSTMENTS ON OVERALL BOILER EFFICIENCY AND A PROGRESS REPORT ON RESEARCH.
L. E. Seeley, May ... 423
Co-operative Research Paper, Studies Contemplated, Economy Comparison of Continuous Tests.

Electric Heating, Notes on, Nov. ... 967
Ewald, Warren, Noise Reduction in Ventilating Units, Nov. ... 968
Exposition, Heating and Ventilating, Jan. ... 73
Report of, Mar. ... 266

FACTOR IN THE TEMPERATURE OF THE STRATOSPHERE.
W. J. Humphreys, Sept. ... 791
Expansion of Ascending Air, Temperature Changes in Upper Atmosphere, Equatorial Regions.

Farnham, Roswell, Buffalo Engineers Honor, Aug. ... 716
Fitts, J. C., Elected Secretary H. P. C. N. A., Sept. ... 799
FOURTH NATIONAL FUELS MEETING PROGRAM, Nov. ... 979
Fowler, L. J., Panel Warming, Jan. ... 47
Giesecke, F. E., Loss of Head in Submerged Orifices, July ... 611
Guide Publication Committee, Report on, Mar. ... 259
Aug. ... 700
Gunther, F. A., Economic Use of Steam in Modern Buildings, June ... 527
Gutberlet, Carl, Air Leakage Through Various Forms of Building Construction, Dec. ... 1044
Gutberlet, Carl, Capacity of Dry Return Mains for Steam and Vapor Heating Systems, Aug. ... 687
Gutberlet, Carl, Capacity of Return Risers for Steam and Vapor Heating Systems, Oct. ... 859
Harding, L. A., Application of Heating and Ventilating Research, Sept. ... 788
Harding, L. A., Presentation to, July ... 623
Harding, L. A., Proposed Visit to Western Chapters in October, Sept. ... 799
Harding, L. A., Schedule of Chapter Visits, Oct. ... 884
Harding, L. A., Speaks on Westinghouse Program to Heating and Ventilating Industry, May ... 442
Harrington, Elliott, Off-Peak System of Electric Heating for Buildings, Nov. ... 963
HEATING AND VENTILATING CONGRESS, BRUSSELS, May ... 438
Heating and Ventilating Exposition, Jan. ... 73
Report of, Mar. ... 266
Heating and Ventilation and Its Relation to Health and Comfort, Report of Committee on, Mar. ... 244

HEAT TRANSFER THROUGH AIR SPACES.
Paul D. Close, Oct. ... 875
Investigations of Various Experimenters Including Bureau of Standards, British Department of Scientific and Industrial Research, University of Illinois, Pennsylvania State College, Karl Hencky and F. B. Rowley.

Heat Transmission, Report of Technical Advisory Committee on, Mar. ... 243
Herbert, C. A., Air Leakage Through Various Forms of Building Construction, Dec. ... 1044
HOT WEATHER SPECIALIST, Sept. ... 787
Houghten, F. C., Air Leakage Through Various Forms of Building Construction, Dec. ... 1044

Houghten, F. C., Capacity of Dry Return Mains for Steam and Vapor Heating Systems, Aug. 687
Houghten, F. C., Capacity of Return Risers for Steam and Vapor Heating Systems, Oct. 859
How Comfort Is Affected by Surface Temperatures and Insulation.
Paul D. Close, Sept. 792
Relation of Wall and Ceiling Temperatures to Comfort, Effect of Insulation on Surface Temperature, Variation in Surface Temperature with Various Factors, Windows, Insulation and Heat Loss by Radiation.
Humphreys, W. J., Factor in the Temperature of the Stratosphere, Sept. 791
Illinois Engineering Experiment Station Building Dedicated, July 621
Index to Coal and Coke Reports of Bureau of Mines, July 616
Infiltration, Report of Technical Advisory Committee on, Mar. 244
Insulating Effect of Successive Air Spaces Bounded by Bright Metallic Surfaces.
L. W. Schad, Nov. 957
Heat Dissipation from Bright Tin Surfaces, Effect of Metallic Screens, Heat Transfer Through Air Spaces, Effect of Screens on Conduction, Convection and Radiation.
Invitation to the Heating and Ventilating Engineers to Visit Various Plants in Philadelphia, Jan. 81
Japanese Translate U. S. Mines Paper, June 526
Klie, Walter, Heads Heating and Piping Contractors, Aug. 715
Kratz, A. P., Wall Surface Temperatures, Apr. 335
Lambert, R. D., Development of a Method for Heat Regulation, Apr. 329
Langsdorf, A. S., Carbon Monoxide Concentration in Garages, Aug. 695
Larson, G. L., Air Infiltration Through Various Types of Wood Frame Construction, June 509
Lewis, Thornton, Philadelphia Chapter Presents Memory Book to, July 623
Loss in Coking Quality of Coal Due to Exposure, June 508
Loss of Head in Surmerged Orifices.
F. E. Giesecke, July 611
Description of Apparatus and Tests, Results of Tests, Practical Application Methods of Results, Use of Orifices.
Measurement of the Flow of Air Through Registers and Grilles.
Lynn E. Davies, Jan. 57
Co-operative Research Paper, Apparatus for Testing Air Flow Through Supply and Exhaust Registers, Discussion of Results, Recommended Procedure for Testing Air Flow by Means of the Anemometer.
Mechanical Analysis Chart Announced, July 616
Mechanized Heating with Anthracite, Mar. 340
Meier, Konrad, Comments on Design and Rating of Direct Radiation, Feb. 164
Method of Choosing Location of, Financing and Conducting Meetings of the Society, June 76
Mine Ventilation, Apr. 356
National Power Show, Nov. 970
Nelson, D. W., Air Infiltration Through Various Types of Wood Frame Construction, June 509
New Society Headquarters in New York Life Building, Mar. 272
New Ventilation Code for New York City, Nov. 962
New York University Announces Evening Courses, Nov. 979
Noise and Ventilation.
G. T. Stanton, Dec. 1049
Noise Measuring Instruments, Standardization of Noise Measurements, Audiograms of Outdoor Noise.
Noise Reduction in Ventilating Units.
Warren Ewald, Nov. 968
Sources of Sound, Sound Absorption, Selection of Materials, Sound Interference.
Nominating Committee, Report of, Aug. 712
Nominations for Officers of the Society for 1930, Jan. 67
Nominations for Officers of the Society for 1931, Oct. 879
Nominations for Officers of the Society for 1931, Nov. 971
O'Bannon, L. S., Suggested Method of Testing Unit Heaters Suitable for Field Use, Feb. 153
Officers and Council Members, Apr. 349
Off-Peak System of Electric Heating for Buildings.
Elliott Harrington, Nov. 963
Cost Data, Advantages of Electric Heating, Discussion of Off-Peak System, Domestic Water Heating.
Oil Burning Devices, Report of Technical Advisory Committee on, Mar. 244
Aug. 710
Outcalt, F. G., Welded Piping for Building Heating Systems, Oct. 855
Panel Warming.
L. J. Fowler, Jan. 47
Temperatures Used, Layout of System, Method of Calculating Pipe Coils, Economy Obtainable.
Papers, List of, Published in Transactions to Date, Apr. 359
Papers Presented Before the A. S. H. V. E. Classified According to Subjects, May 429
Past-President's Meeting, May 447
Pipe and Orifice Sizes for Small Gravity Circulation Hot Water Heating Systems.
Elmer G. Smith, Feb. 135
Co-operative Research Paper, Sizes of Pipes and Orifices, Sizes of Risers, Mains and Heater for One-Story Residence Problem, Settings for Valves Having Adjustable Orifices, Branched Circuits, Two-Story Buildings, Improving Old Systems.
Pipe Sizes, Report of Committee on, Aug. 711
President Harding Speaks on Westinghouse Salute Radio Program to Heating and Ventilating Industry, May 442
President Harding to Visit Western Chapters in October, Sept. 799
President's Page, Jan. 69
May 439
Proper Size of Coke for Domestic Heating Furnaces, Apr. 356
Proposed Standard Smoke Ordinance, June 508
Rate of Pure Carbon in Air, July 621
Rating of Heating Boilers by Their Physical Characteristics.
C. E. Bronson, Jan. 54
Single Number Rating, Relation of Boiler Ratings to Heating Surface, S. H. B. I. Code for Rating of Low Pressure Heating Boilers.
Raymond, F. I., Development of a Method for Heat Regulation, Apr. 329
Recommended Revision of the January, 1929, A. S. H. V. E. Code for Rating Steam Heating Solid Fuel Hand-Fired Boilers, Mar. 255
Regulations Governing Research Committee, Mar. 245
Relative Humidity, Apr. 365
Report on Powdered Coal, Jan. 76
Reports.
Committee on Research, Mar. 241
Committee on Research, Aug. 701
Committee on Air Cleaning Devices, Mar. 242
Committee on Testing and Rating Unit Heaters, Mar. 243
Committee on Heat Transmission, Mar. 243
Committee on Infiltration, Mar. 244
Committee on Heating and Ventilation and Its Relation to Health and Comfort, Mar. 244
Committee on Oil Burning Devices, Mar. 244
Committee on Oil Burning Devices, Aug. 710
Continuing Committee on Codes for Testing and Rating Steam Heating Solid Fuel Boilers, Mar. 251
Guide Publication Committee, Mar. 259
Guide Publication Committee, Aug. 700
Committee to Investigate Cause of Loss of Membership in the Society, Mar. 236
Finance Committee, Mar. 236
Tellers of Election, Mar. 233
President, Mar. 233
Secretary, Mar. 235
Council, Mar. 235
Committee on Pipe Sizes, Aug. 711
Nominating Committee, Aug. 712
Research Director, Aug. 702
Research Committee, Regulations Governing, Mar. 245
Research Director, Report of, Aug. 702
Research, Report of Committee on, Mar. 241
Aug. 701
Research Executive Secretary Appointed, Mar. 272
Rowley, F. B., Surface Conductances as Affected by Air Velocity, Temperature and Character of Surface, June 501
Schad, L. W., Insulating Effect of Successive Air Spaces Bounded by Bright Metallic Surfaces, Nov. 957
Schedule of Chapter Visits for President Harding, Oct. 884
Seeley, L. E., Effect of Oil Burner Adjustments on Overall Boiler Efficiency and a Progress Report on Research, May 423
Semi-Annual Meeting, Minneapolis, June 24-27, 1930.
Plans for, May 440
June 531
Proceedings of, Aug. 698, 713
Smith, Elmer G., Pipe and Orifice Sizes for Small Gravity Circulation Hot Water Heating Systems, Feb. 135
Southern California Chapter Organized in Los Angeles, Aug. 716
Southern California Members Meet, Sept. 800
Special Society Committees Appointed, Sept. 800
Standard Code for Testing and Rating Steam Unit Heaters, Apr. 341
Stanton, G. T., Noise and Ventilation, Dec. 1049
Stark, W. E., Control Equipment for Gas Burner Heating Appliances, July 617
Steam Tables Issued, June 538
Suggested Method of Testing Unit Heaters Suitable for Field Use.
L. S. O'Bannon, Feb. 153
Condensate Nozzle Method, Suitability of Method for Field Tests, Derivation of Conversion Formulae.
Sun Effect on Buildings, Sept. 796
Surface Conductances as Affected by Air Velocity, Temperature and Character of Surface.
F. B. Rowley, A. B. Algren and J. L. Blackshaw, June 501
Points to Be Considered, Data Recorded, Results of Tests, Increase of Surface Conductances with Increase of Mean Temperature and Wind Velocity.
Testing and Rating Unit Heaters, Report of Technical Advisory Committee on, Mar. 243
Tests of Disc and Propeller Fans.
A. I. Brown, Feb. 157
Fan Ratings, Power Required by Perfect Fan, Standard Code Method, Comparison of Ratings by Different Test Methods, Measurement of Low Velocities, Airplane Propeller Fans.
Tests of Disc and Propeller Fans, Corrections for Paper, Mar. 265
Tests of Secondary Air-Mixing Devices for Domestic Furnaces, May 438
Tucker, R. R., Carbon Monoxide Concentration in Garages, Aug. 695
Unit Heaters, Report of Technical Advisory Committee on Testing and Rating, Mar. 243
Utilization of Waste Heat.
Perry West, Nov. 947
Economic Aspects, Heating with Exhaust Steam, Adjustment Between Heating Loads and Exhaust Steam, Procedure for Making Analysis, Power from Process Steam.
Walker and Crocker Piping Handbook Announced, June 526
Wall Surface Temperatures.
A. C. Willard and A. P. Kratz, Apr. 335
Effect of Cold Wall Surfaces, Temperatures in Zone of Occupancy, Distinction Between North and South Rooms Having Same Calculated Heat Loss, New Significance of Insulation.
Weber, E. L., An Automatic System of Hot Water Heating and Hot Water Supply, Dec. 1053
Welded Piping for Building Heating Systems.
F. G. Outcalt, Oct. 855
Efficiency and Economy of Welded Construction, Joint Designs, Fittings for Welded Piping, Headers, Adaptability of the Oxy-Acetylene Process.
Welding, Notes on, Oct. 858
Westinghouse Memorial Dedicated, Nov. 976
West, Perry, Utilization of Waste Heat, Nov. 947
Willard, A. C., Wall Surface Temperatures, Apr. 335
Wilson, G. S., Centrifugal Fans, Sept. 797
World Engineering Congress, Feb. 169
Yaglou, C. P., Application of Air Conditioning to Premature Nurseries in Hospitals, July 605

Columbus Htg. & Vent. Co., Columbus, O.
Sturtevant Co., B. F., Boston
Wing Mfg. Co., L. J., New York

VENTILATORS, UNIT
Buckeye Blower Co., Columbus, O.
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Index *to* Advertisers

Aerofin Corp. 46
Air Reduction Sales Co.....154
American Air Filter Co., Inc.....160
American Radiator Co..... 18
Ames Pump Co., Inc..... 7
Armstrong Machine Works.....140

Barnes & Jones, Inc. 158
Buckeye Blower Co., The..... 26
Buffalo Forge Co..... 20
Burnham Boiler Corp..... 38

Carbondale Machine Co., The.....159
Carrier Corp. .....42 and 43
Clarage Fan Co.....Inside Front Cover
Cleghorn Company.....148
Consolidated Ashcroft Hancock Co., Inc. 27
C. S. B. Sprinkler Company.....148

Dart Mfg. Co., E. M..... 25
Davis Regulator Co.....164
Detroit Stoker Co....Inside Back Cover
Dixie Blower Company..... 10
Dresser Mfg. Co., S. R.....141
Dunham Co., C. A..... 34
Duriron Co., Inc., The.....177

Erie City Iron Works.....162

Fairbanks Co., The..... 25
Fitzgibbons Boiler Co., Inc.....159
Foxboro Company, The.....152
Frank Heater & Eng. Co., O. E.....162

Grinnell Co. .....Back Cover

Heggie-Simplex Boiler Co..... 5
Hoffman Specialty Co., Inc.....145

Illinois Engineering Co. 178
Insulite Co., The.....149

Johnson Service Co..... 41

Kennedy Valve Mfg. Co. The.....148
Kewanee Boiler Corp..... 3
Kieley & Mueller, Inc.....163

Leavitt Machine Co., The.....152
Limbert & Co., Geo. B..... 40
Lynchburg Foundry Co.....150

Marsh & Co., Jas. P..... 11
Maryland Air Conditioning Corp....155
McDonnell & Miller.....143
Midwest Piping & Supply Co., Inc...164
Minneapolis-Honeywell Regulator Co.139
Modine Mfg. Co.....164
Multicell Radiator Corp..... 6

Nash Engineering Co.....31, 32 and 48
National Pipe Bending Co.....160
National Regulator Co..... 13
National Tube Co..... 37
Niagara Blower Co.....144

Oil City Boiler Works..... 19

Peerless Unit Ventilation Co., Inc... 17
Pennsylvania Forge Corporation....156
Perfex Corporation 4
Philadelphia Pipe Bending Co., The..157
Power Piping Co.....144
Powers Regulator Co..... 22

Raymond Co., F. I..... 29
Reading Iron Co..... 15
Republic Steel Corp.....16 and 164
Ric-wil Co., The.....153
Roessing Mfg. Co.....161
Rome-Turney Radiator Co.....156

Sarco Co., Inc..... 39
Schwitzer-Cummins Co. 14
Sims Company, The.....142
Skinner Bros. Mfg. Co., Inc..... 30
Skidmore Corp. 154
Spang, Chalfant & Co., Inc..... 21
Stat-Amatic Instrument & Appliance Co. 160
Sterling Engineering Co.....162
Stockham Pipe & Fittings Co.....162
Strong, Carlisle & Hammond..... 23
Sturtevant Company, B. F..... 44

Taylor Forge & Pipe Works.....161
Trane Company, The.....8, 9 and 142
Tube-Turns, Inc. 35

Union Carbide & Carbon Co..... 33
U. S. Blower & Heater Corp.....150

Warren Webster & Co..... 24
Watts Regulator Company.....153
Westinghouse Electric & Mfg. Co... 36
Williams & Co., J. H.....157
Wing Mfg. Co., L. J.....163
Wolverine Tube Co.....160

York Heating & Ventilating Corp....28

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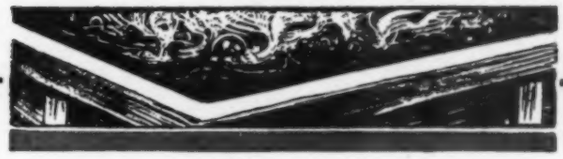

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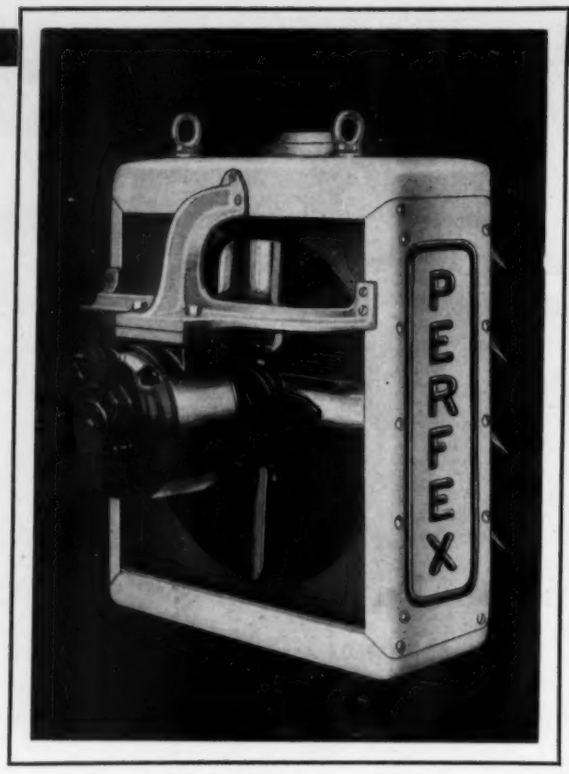

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"HEAT RADIATION SPECIALISTS FOR MORE THAN TWENTY YEARS"

HEATING, PIPING and AIR CONDITIONING, Published monthly by Engineering Publications, Inc., 1900 Prairie Ave., Chicago, Ill. Subscription rates: $3.00 per year, anywhere in the world; single copies, 50 cents. Back numbers, $1.00. December, 1930, Vol. 2, No. 12. Entered as Second Class Matter May 18, 1929, at the Post Office at Chicago, Illinois, under the Act of March 3, 1879.

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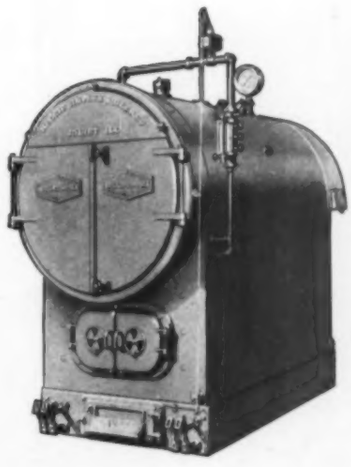

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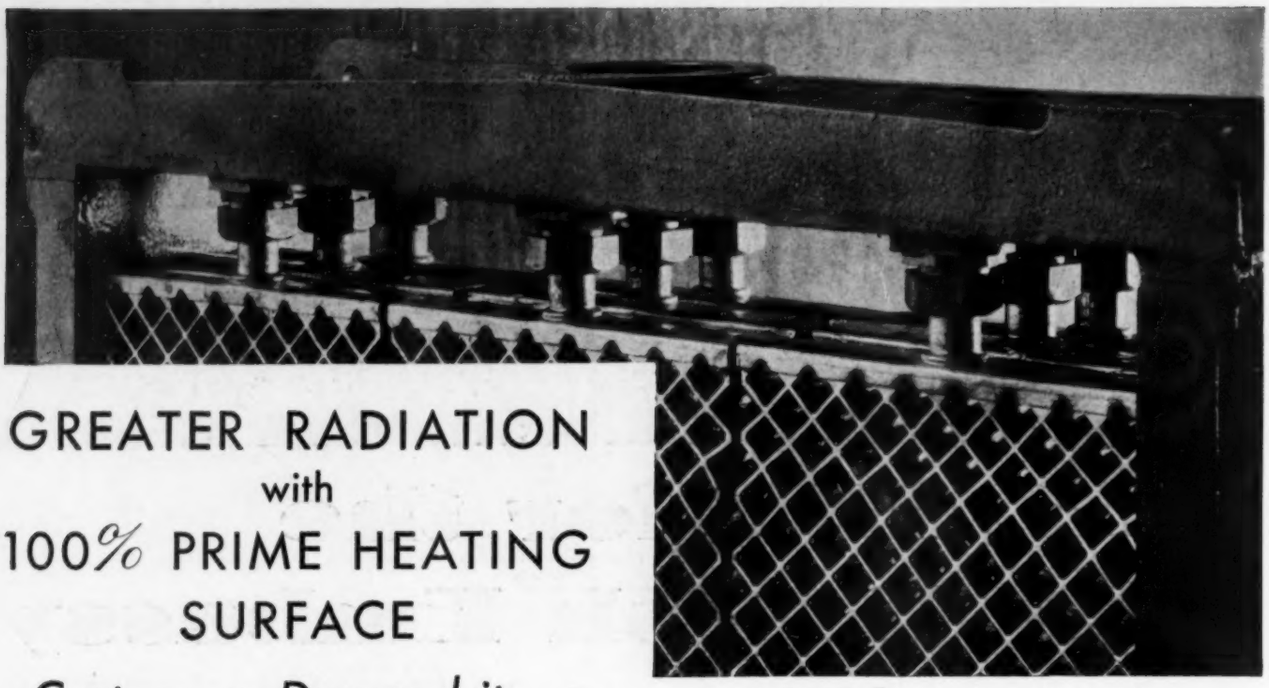

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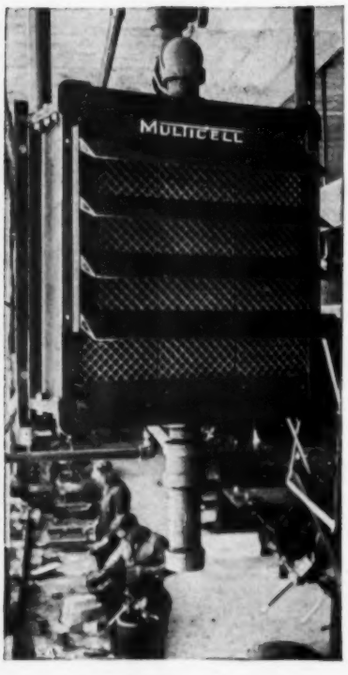

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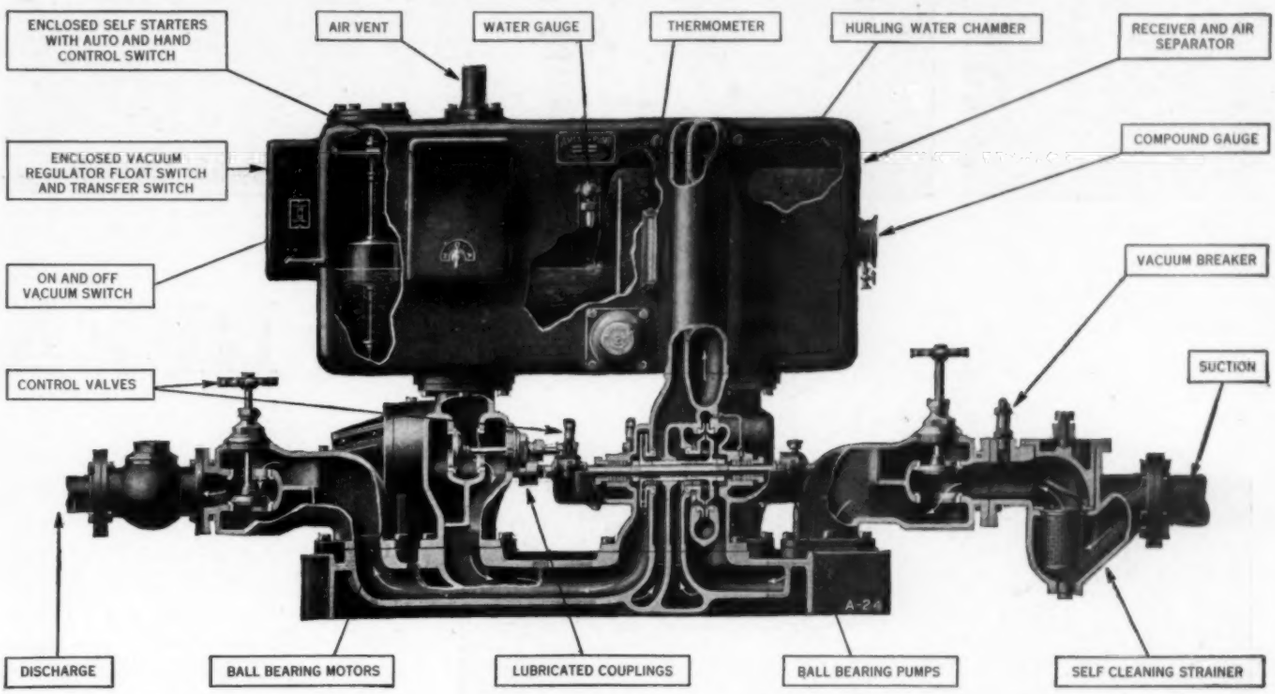

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Comparisons such as this reveal the value of the AMES Pump and emphasize the fact that it is

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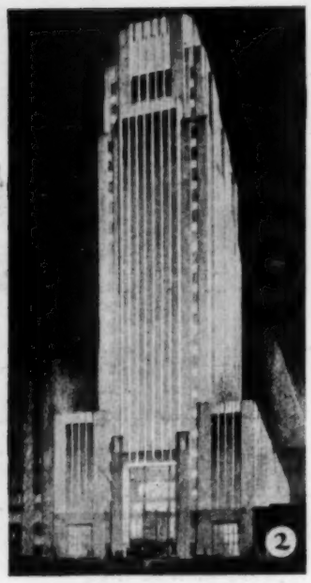

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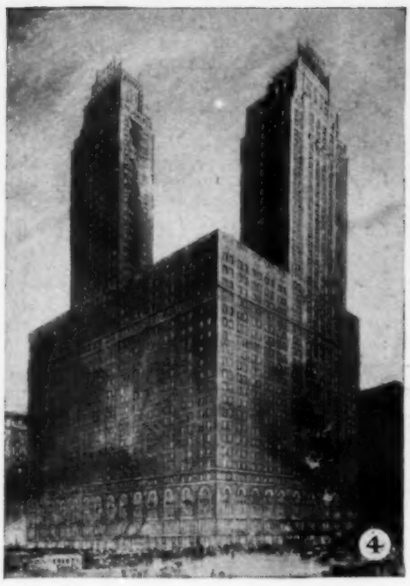


A TRANE YEAR

1—No. 10 Gracie Square, New York, N. Y. Apartment Building. *Architects:* Van Wort & Wein. *Heating Contractors:* Zibold & Donohue. *General Contractors:* T. E. Rhoades Company. **938 Trane Concealed Heater Units Installed.**

2—1616 Walnut Street, Philadelphia, Pa. Office Building. *Architects:* Tilden, Register & Pepper. *Heating Contractors:* Keystone Plumbing & Heating Company. *General Contractors:* Wark Company. **523 Trane Concealed Heater Units Installed.**

3—No. 1 East End Avenue, New York, N. Y. Apartment Building. *Architects:* Pennington & Lewis. *Heating Contractors:* E. Rutzler Company. *General Contractors:* James Stewart Company. **441 Trane Concealed Heater Units Installed.**

4—Addition to Morrison Hotel, Chicago, Ill. *Architects:* Holabird & Root. *Heating Contractors:* Mehring & Hanson. *General Contractors:* John Griffiths & Son Company. **440 Trane Concealed Heater Units Installed.**

5—New Central Young Men's Christian Association Building, Akron, Ohio. *Architects:* Good & Wagner. *Heating Contractors:* Forbs-Stanford Company. *General Contractors:* Clemmer-Noah Construction Company. **403 Trane Concealed Heater Units Installed.**

6—Banks-Huntley Building, Los Angeles, Cal. *Architects:* John and Donald B. Parkinson. *Heating Contractors:* F. D. Reed Plumbing Company. *General Contractors:* L. E. Dixon Company. *Mechanical Engineer:* Ralph Phillips. **224 Trane Concealed Heater Units Installed.**

7—Addition to Southern Pacific Building, San Francisco, Cal. *Architects:* Coffey & Rist. *Heating Contractors:* Frank J. Klimm Company. *General Contractors:* Barrett & Hilp. *Mechanical Engineers:* Robert L. St. John's Company. **187 Trane Concealed Heater Units Installed.**

8—Francis Hotel, Monroe, La. *Architects:* Wyatt C. Hedrick, Inc., Fort Worth, Tex. *Heating Contractors:* W. J. Riley Plumbing and Heating Company. *General Contractors:* Ashton Glassell Company, Shreveport, La. **350 Trane Concealed Heater Units Installed.**

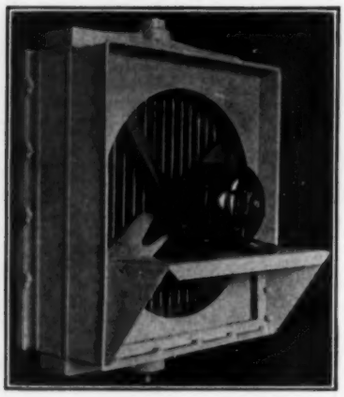
9—Doctors Building, Atlanta, Ga. *Architects:* Pringle & Smith. *Heating Contractors:* Stephenson Company, Inc. *General Contractors:* Southern Ferro Concrete Company. **396 Trane Concealed Heater Units Installed.**

10—Hotel Brownwood, Brownwood, Texas. *Architects:* Wyatt C. Hedrick, Inc., Fort Worth, Texas. *Heating Contractors:* J. C. Korioth Plumbing & Heating Company, Sherman, Texas. *General Contractors:* J. O. Everett Company, Dallas, Texas. **278 Trane Concealed Heater Units Installed.**

11—St. Elizabeth Hospital, Chicago, Ill. *Architects:* Hermann J. Gaul & Son. *Heating Contractors:* Glennon-Bielke Company. *General Contractors:* John Gebhardt & Son. **501 Trane Concealed Heater Units Installed.**

12—Loren M. Post School, Detroit, Mich. *Architects:* McGrath & Dohmen. *Heating, Ventilating and Plumbing:* Freyn Brothers. *General Contractors:* Culbertson & Kelly. *Consulting Engineers:* Van Tuyl, Heartt & Barron. **134 Trane Concealed Heater Units Installed.** (14 other Detroit schools similarly equipped.)

if fuel costs are running *too high*



Here's the solution to heating problems, to high fuel costs, to unsatisfactory results, to decreased working efficiency: Dixie Unit Heaters.

Check up now—today—find out what your heat has been costing you; find out if your workers have been comfortable, if they have been working at top efficiency.

If you discover that fuel costs are running too high, if you find that your men have been uncomfortably warm or cold and that production has been interfered with because of this condition, write us, enclosing your findings and telling us about the size of your plants.

Let our engineers solve this all-important heating problem for you. Let them show you how, with Dixie Unit Heaters, you can reduce costs materially and at the same time keep your shop, factory or office in uniformly healthy shape for better work.

	Air Entering Heater	Air Leaving Heater	B.T.U Per Hour	Condensate Per Hour	Equivalent Square feet Direct Radiation	Cubic Feet Air Per Minute	Shipping Weight
No 300 B	40° F	150° F.	232620	242 lbs.	960	3200	230 lbs.
	50	136	218250	227	908	3200	230
	60	141	205340	214	856	3200	230
	65	143	200500	208	832	3200	230
	70	144	193510	202	808	3200	230
No. 300	40°	130°	146080	155 lbs.	612	1300	170 lbs.
	50	135	138240	146	576	1300	170
	60	143	128000	136	537	1300	170
	65	145	124800	134	520	1300	170
	70	147	121160	129	509	1300	170
No. 200	40	134°	50000	53 lbs.	212	920	120 lbs.
	50	138	45120	47	188	920	120
	60	142	40320	42	168	920	120
	65	143	38400	40	160	920	120
	70	144	34520	37	148	920	120

The Dixie Unit Heater table at the left tells you only a part of what Dixies are doing in all of their installations. Get the rest of the Dixie story today. Write for complete details. You place yourself under no obligation.

The Dixie Blower *Company*

1351 West 37th Place ∴ Chicago

Marsh System Unit Radiator Valve

Marsh System Unit Radiator Trap

Marsh Air and Vacuum Valve

Marsh System Unit No. 9
Heavy Duty Trap

MARSH

presents

truly modern heating

at the

POWER SHOW

Booths No. 258-259 Dec. 1st to 6th

The products shown on this page illustrate a small part of the complete Marsh Line ... but they cannot illustrate the enduring quality, the painstaking workmanship and the progressive engineering that are so vital a part of every Marsh System Unit and Marsh Heating System.

Come to Booths 258-259 at the Power Show and learn more about these products that are revolutionizing modern heating practice. Let our representative demonstrate the operating model of a Marsh Weather Compensating System of heating. He can give you conclusive evidence of the marked increase in economy and efficiency that results from the application of Marsh System Units.

JAS. P. MARSH & CO.

(Division of Commercial Instrument Corporation)

HOME OFFICE:

2077 Southport Ave., CHICAGO, ILL.

551 Fifth Ave., New York City — 2539 Pennsylvania Ave., N. W.

Bendix Bldg., Los Angeles, Calif. — Sales Offices in principal cities — Washington, D. C.

Marsh Type W Control Panel

Marsh System Unit
Equalizer and Return Trap

Marsh System Unit No. 8
Drip Trap

Marsh System Unit No. 12
Drip Trap

They BUY ~a million motors every year!

Electric motors—one million of them every year—are required to drive the various fans and blowers, unit heaters, pumps, oil burners, stokers, controls, valves, etc., which large construction uses and which the operating engineer in charge of heating, piping and air conditioning must keep running at top efficiency.

These motors drive such equipment in the nation's larger and industrial types of buildings. And motors is only one of the classifications of equipment which these men specify or actually purchase for their buildings.

They spend millions of dollars for other equipment; in fact, for any equipment which is used in heating, piping or air conditioning, *they* are the buyers.

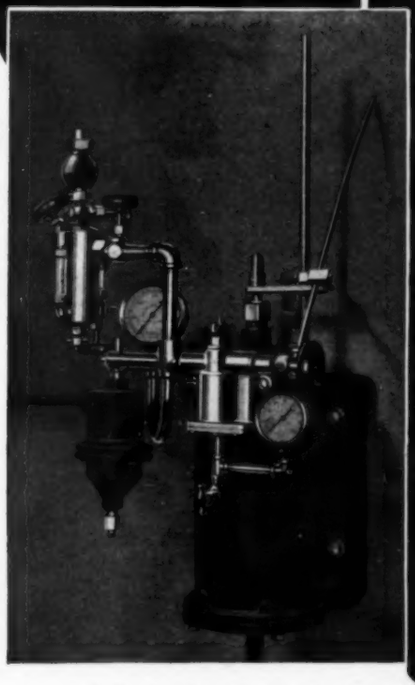
Would you like to have the complete story of these men and how they are served by *one* technical journal, HEATING, PIPING and AIR CONDITIONING? If you have a product for any of these services, write today for the complete story.

HEATING • PIPING *and* AIR CONDITIONING

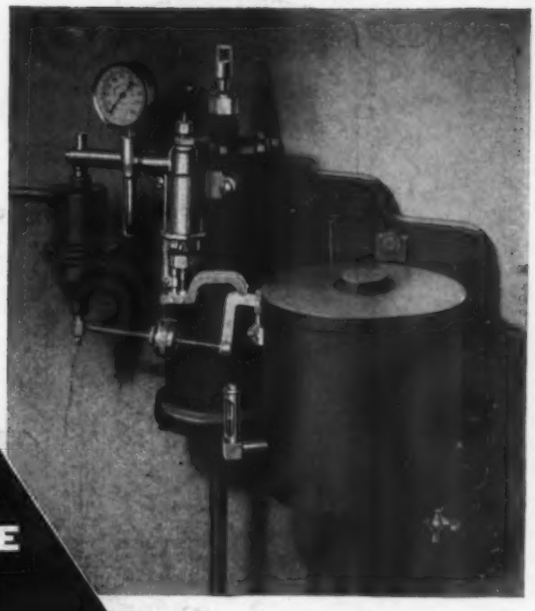
1900 Prairie Avenue Chicago, Ill.

A-JACKS AUTOMATIC CONTROL for HIGH PRESSURE BOILERS

STOKER FEED
BLOWER SPEED
STEAM PRESSURE
FURNACE PRESSURE



A-Jacks for Control of Steam Pressure



A-Jacks for Control of Furnace Pressure

A-JACKS Control for High Pressure Boilers is a combination of equipment that accurately controls stokers, blowers and dampers to maintain even boiler pressure.

A bulletin, just published, gives details of design, operation and installation. A copy will be mailed to you on request.

NATIONAL REGULATOR CO.
2306 Knox Avenue - - - Chicago

NATIONAL REGULATOR CO.,
2306 Knox Ave., Chicago.

Send us copy of new bulletin—"A-JACKS Control for High Pressure Boilers."

Name.....

Address.....

Town..... **State**.....

Attention of.....

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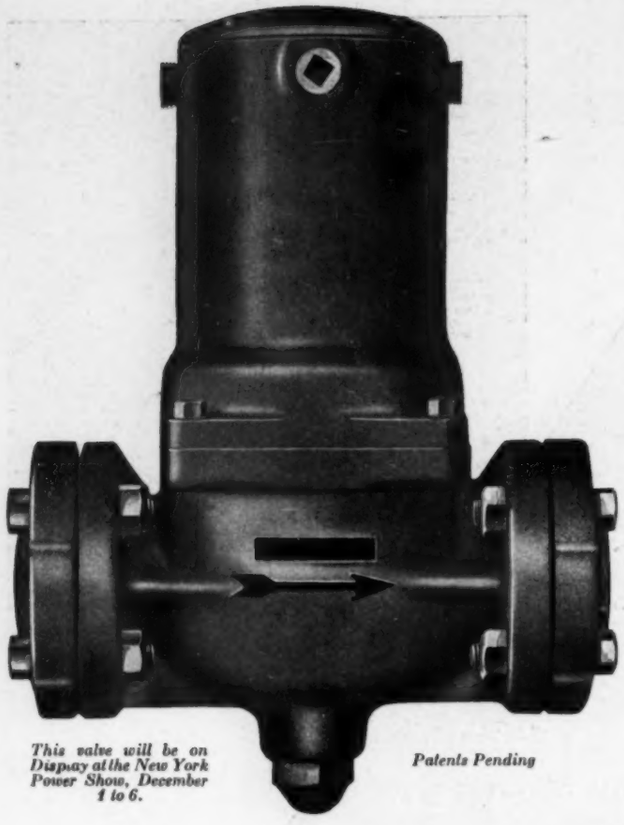


This valve will be on Display at the New York Power Show, December 1 to 6.

Patents Pending

CARRAWAY AUTOMATIC VALVE

no motor — no gears — only two moving parts — packless — "all on, all off" — silent — positive — instantaneous — nothing to fail or get out of order.

THE Carraway Automatic Packless Valve has thousands of economical applications in steam, water, air, oil, gas, refrigeration, etc., lines. IT HANDLES PRESSURES FROM 4 OZ. TO 250 POUNDS, IS CAPABLE OF WITHSTANDING HIGH TEMPERATURES, AND CAN BE USED FOR OBNOXIOUS, CORROSIVE AND INFLAMMABLE GASES AND LIQUIDS, SUCH AS **AMMONIA,** SULPHUR-DIOXIDE, ETC.

The Carraway Automatic Packless Valve can be automatically controlled according to changes of pressure, temperature or flow volume. It may also be controlled by push-button or clock mechanism.

The Carraway is either all on or all off. It is silent and without gears, there is not the clash and wear that usually accompanies the use of such gears.

It is rigid in construction, instantaneous in response and a time and labor saver. It is made of the best materials available, with workmanship guaranteed by a manufacturer of twelve years' established reputation in the automotive and industrial fields.

Write today for full details of how the Carraway may be applied to your pipe lines, giving you either fully automatic or remote control.

SCHWITZER-CUMMINS CO.
INDIANAPOLIS
U. S. A.

Reading 5-Point Pipe—the pipe that defies Time's onslaughts as does no other—protects Bullock's Wilshire Department Store, Los Angeles. John Parkinson and Donald B. Parkinson, architects.

When 5-Point Pipe Goes IN Operating Costs Go DOWN

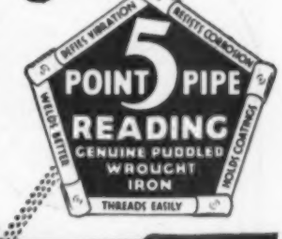
Slash off a goodly share of the operating costs of any building in which Reading 5-Point Pipe is installed. With this rust-resisting, longer-lasting pipe, you can definitely figure that pipe maintenance costs—an important item of operation—will be from one-third to one-half lower than ordinary pipe. That's why it pays to keep Reading 5-Point Pipe in your specifications, even when other items must be sacrificed.

Reading 5-Point Pipe is made by the country's largest manufacturer of Genuine *Puddled* Wrought Iron—the pipe material that defies Time—That Tough Old Tester. More than eighty years of use in the buildings and industries of the Nation prove that it lasts. Our nearest representative will gladly give you the profitable facts.

READING IRON COMPANY, Reading, Pennsylvania

Use only Reading 5-Point Nipples with Reading 5-Point Pipe . . . you'll know them by the indented spiral band.

For Your Protection, This Indented Spiral forever Marks All



GENUINE PUDDLED WROUGHT IRON
READING PIPE
DIAMETERS RANGING FROM ⅛ TO 24 INCHES

Science and Invention Have Never Found a Satisfactory Substitute for Genuine Puddled Wrought Iron

MEASURE

REG.U.S.PAT.OFF.
TONCAN
COPPER
MO·LYB·DEN·UM
IRON PIPE

with a YARDSTICK OF 365 DAYS

By no other standard can the true value of Toncan Iron Pipe be gauged properly. Compared with ordinary pipe—in measurements of 365 days—the longer life of Toncan Iron Pipe is most convincing. It is a trouble-free pipe of highly refined iron, copper and molybdenum, with permanence processed into every tiny grain of metal. Use the 365-day yardstick to determine how much any pipe will cost—and Toncan Iron Pipe certainly will cost less.

For more than 20 years, Toncan Iron has been successfully combating rust and corrosion. Toncan Iron Pipe has demonstrated in service in every industry its ability to keep on working faithfully and economically, years after other ferrous pipe has had to be replaced.

The story of Toncan Iron Pipe for Permanence will be sent to pipe users gratis upon request.

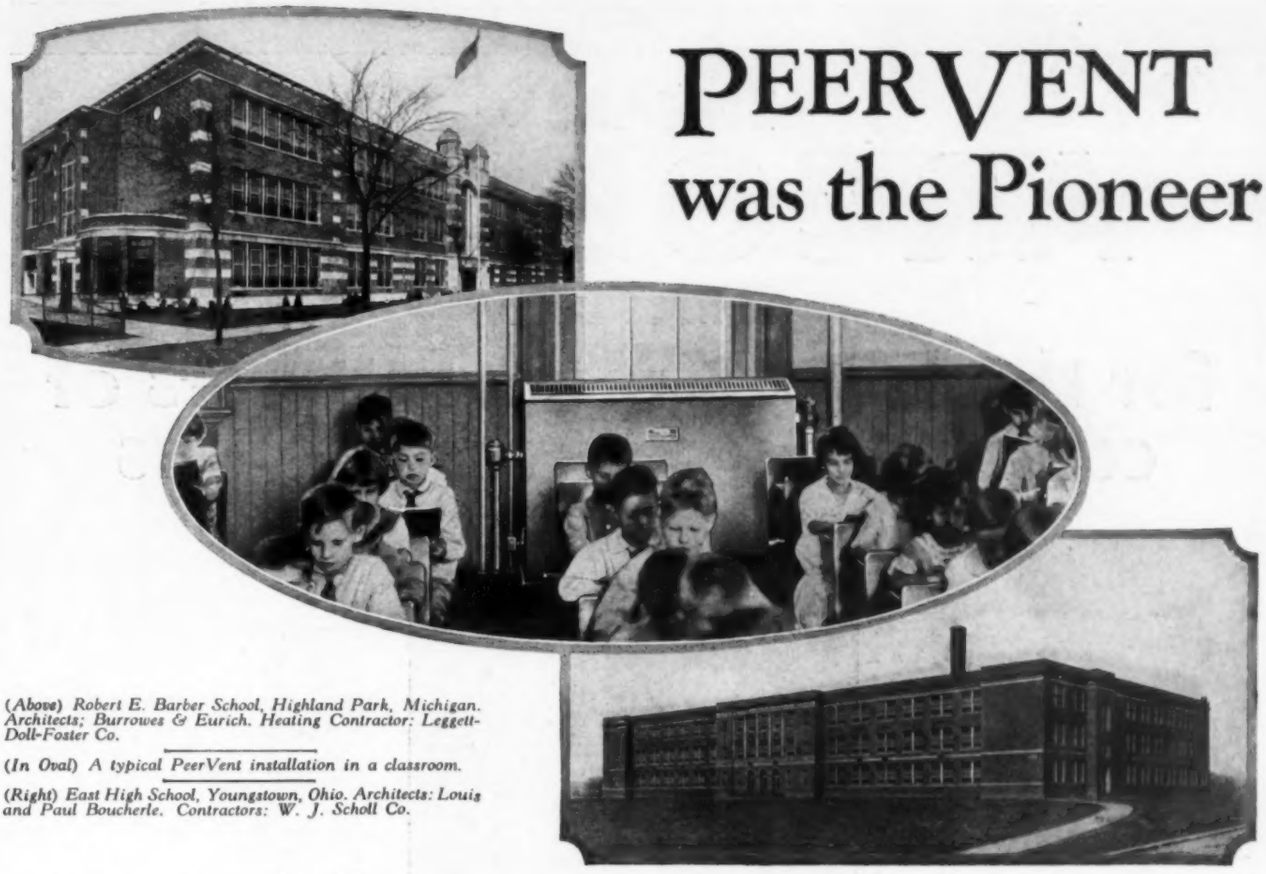
as protection to you we mark it BLUE

REPUBLIC STEEL CORPORATION

GENERAL OFFICES YOUNGSTOWN, OHIO

BIRMINGHAM DENVER PHILADELPHIA BOSTON DETROIT PITTSBURGH BUFFALO EL PASO CHICAGO INDIANAPOLIS SAN FRANCISCO CINCINNATI MILWAUKEE SEATTLE CLEVELAND LOS ANGELES ST PAUL DALLAS NEW YORK ST. LOUIS TULSA TOLEDO

PEERVENT was the Pioneer



(Above) Robert E. Barber School, Highland Park, Michigan. Architects; Burrowes & Eurich. Heating Contractor: Leggett-Doll-Foster Co.

(In Oval) A typical PeerVent installation in a classroom.

(Right) East High School, Youngstown, Ohio. Architects: Louis and Paul Boucherle. Contractors: W. J. Scholl Co.

PeerVents should be used not only in schools but in such other public or semi-public buildings as theatres, department stores, hotels, churches, banks, auditoriums, offices, etc., where large numbers of people gather and where extreme conditions for heating and ventilating exist.

PEERVENTS installed 19 years ago still give satisfactory and efficient service. These first units were then based on 22 years of experience in the heating and ventilating field. The PeerVent of today employs the same basic principles, but the recent models are greatly improved in construction and mechanical excellence—better radiator, better fans, better motors, etc. Peerless is always a little in advance with improvements.

PeerVents are constructed on sound engineering principles, exceptionally well built and absolutely noiseless in operation.

The PeerVent Heating and Ventilating Unit fully meets all requirements of the most stringent state and municipal codes covering the ventilation of school buildings.

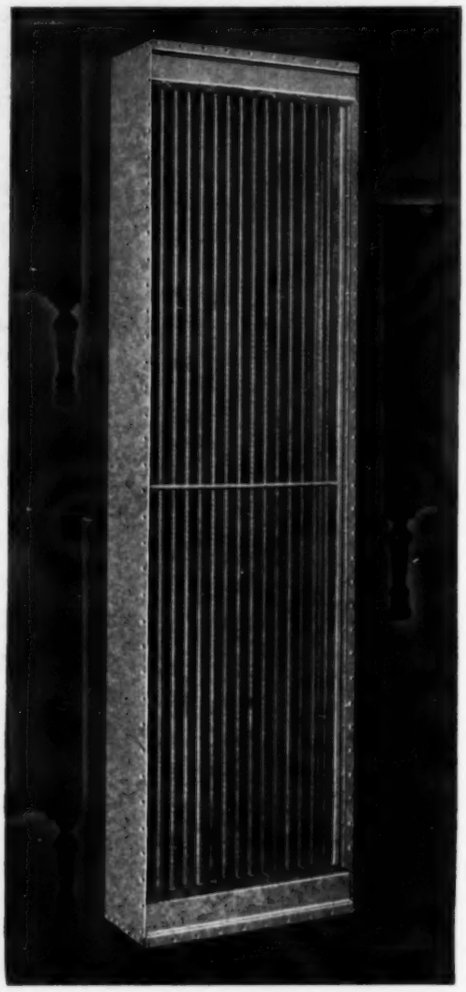
Write for the Peerless catalog describing and illustrating PeerVents.

PEERVENT

PEERLESS UNIT VENTILATION CO., Inc.
BRIDGEPORT, CONNECTICUT
Pioneers in Unit Ventilation
Resident Engineers in Principal Cities from Coast to Coast

ENCASED ARCOBLAST HEATERS

for the largest manufacturers of COMPLETE RADIO RECEIVING SETS



In the Spray-Booth Building of Grigsby-Grunow Company in Chicago, manufacturers of Majestic Radios, 6100 lineal feet of Arcoblast are supplying fresh air.

Here is another case where the high efficiency and light weight of Arcoblast make it the ideal radiation for perfect ventilation

Heating Engineer—Martin C. Schwab, Chicago Heating Contractor—John R. Kehm Company, Chicago Fan Equipment — American Blower Company.

AMERICAN RADIATOR COMPANY

DIVISION OF

AMERICAN RADIATOR & STANDARD SANITARY CORPORATION

816 So. Michigan Ave., Chicago 40 West 40th St., New York City

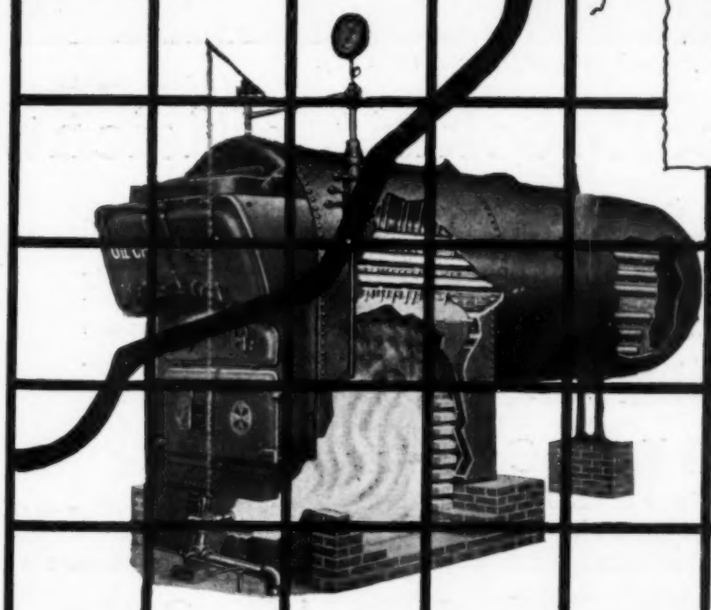
Performance Curves Are Eloquent

100%

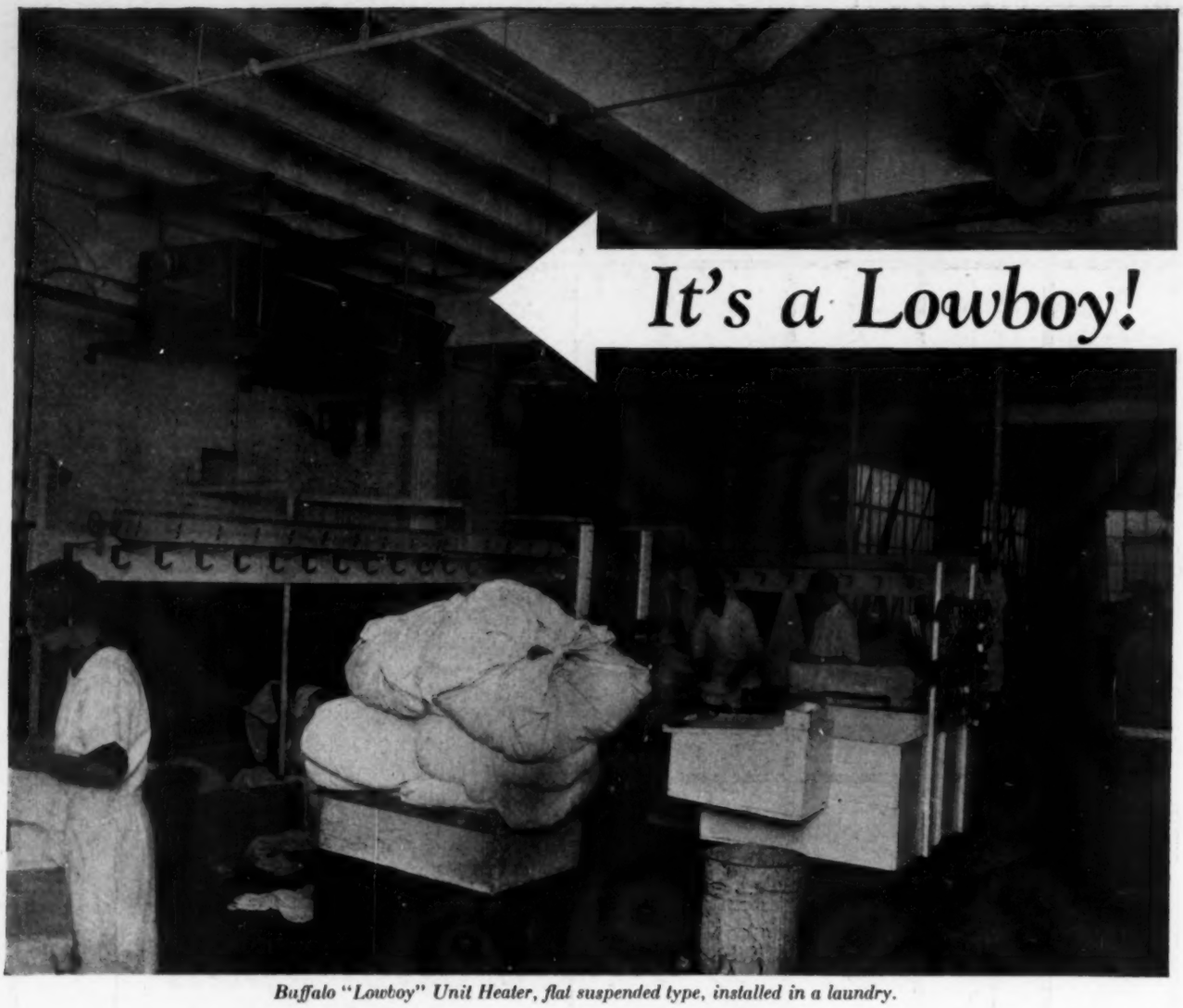
Two boiler factors interest you as an engineer. Careful design and manufacture and—performance. In Oil City Boilers the first of these is easily satisfied. Fifty years of successful experience and conformation to all A.S.M.E. and other strict standards, is enough qualification. And thru the graph, mathematical certainty of performance is just as easily satisfied. Nothing is left to chance. When you write The OIL CITY PORTABLE RETURN TUBULAR FIRE BOX BOILER for Oil Burning, into your specifications you are positive that heating requirements computed will be met. This boiler is particularly adaptable for use with oil as the medium. But it is also just as efficient with coal.

Oil City Boiler Works
Oil City, Pa.

Branches in All Principal Cities
Member of the Steel Heating Boiler Institute



OIL CITY BOILERS



Buffalo "Lowboy" Unit Heater, flat suspended type, installed in a laundry.

and it's husky, good-looking, efficient

The "Lowboy" Unit Heater shown above is one of several similar units installed in this laundry and not only helps keep down heating costs but saves floor space as well.

For plants where floor space is an important consideration, we offer the compact, highly efficient, big capacity "Lowboy." It can be conveniently mounted above factory bins or shelves, along the side walls on brackets in a vertical position or horizontally in roof trusses.

If you are not thoroughly acquainted with the low cost of heating with the "Lowboy" or other Buffalo Unit Heaters, let us send you a copy of our new illustrated Unit Heater catalog.

Buffalo Forge Company

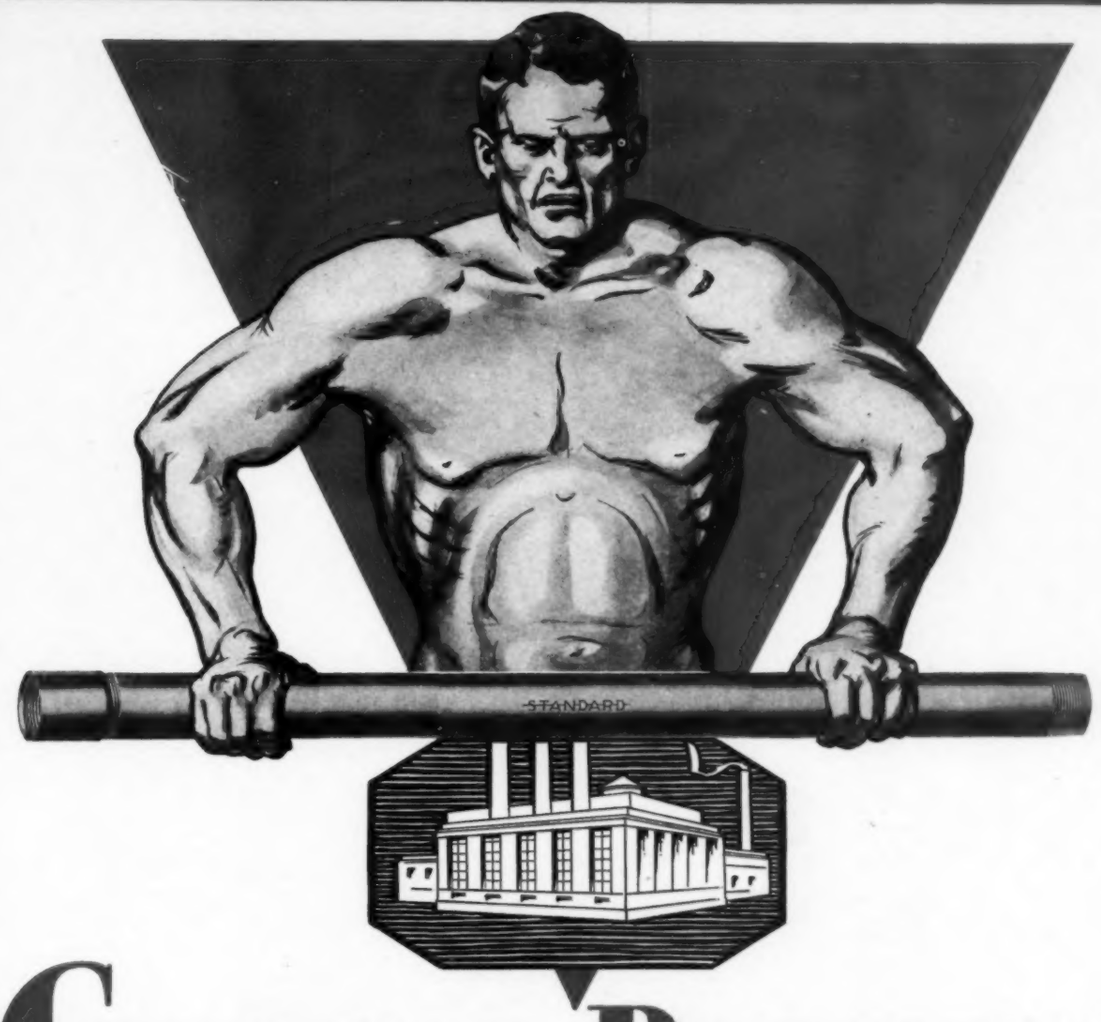
171 Mortimer St., Buffalo, New York

In Canada: Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo"

UNIT HEATERS—STEAM OR GAS FOR EVERY REQUIREMENT

SPANG
WELDED



CEASELESS PRESSURE

The hottest steam and the highest line pressures holds no menace for "Standard" Seamless—the modern Power Piping that meets the most rigid and exacting engineers' specifications.

The unexcelled service record of "Standard" Seamless in many of the country's largest power plants has made it the preferred power piping among prominent engineers the nation over.

SPANG, CHALFANT & CO., INC.

General Offices: **CLARK BUILDING, PITTSBURGH, PA.**

Sales Offices: **CHICAGO, ILL. NEW YORK, N. Y. ST. LOUIS, MO. PITTSBURGH, PA. TULSA, OKLA. LOS ANGELES, CAL.**
Welded Mills: **ETNA, PENNA. SHARPSBURG, PENNA.** ***Seamless Mills:*** **AMBRIDGE, PENNA.**

STANDARD

SEAMLESS · STEEL

POWER · PIPING

STANDARD
SEAMLESS

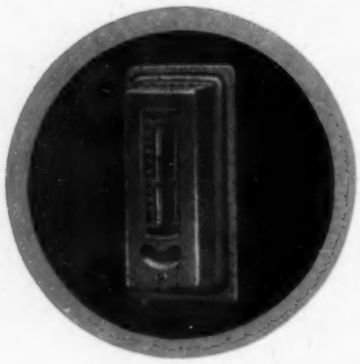
POWERS

THE EXCHANGE BUILDING IN SEATTLE

Architect
John Graham

Engineer
C. H. Knowles

Heating Contractor
The Rautman Plumbing and Heating Co.



Powers Thermostats Are Better

Because—they often give 15 to 25 years of accurate control without repairs of any kind—need no annual adjustment or overhauling—and have no fine restrictions to become clogged by dirt.

Here is another prominent building equipped with the Powers System of Automatic Temperature Control.

Wherever Quality is the chief consideration, you will invariably find the heating and ventilating system regulated by Powers control.

Its first cost is usually higher, but it costs less in the end because: it often gives 15 to 25 years of Accurate and Dependable control with practically no expense for repairs.

THE POWERS REGULATOR COMPANY

35 Years of Specialization in Temperature Control

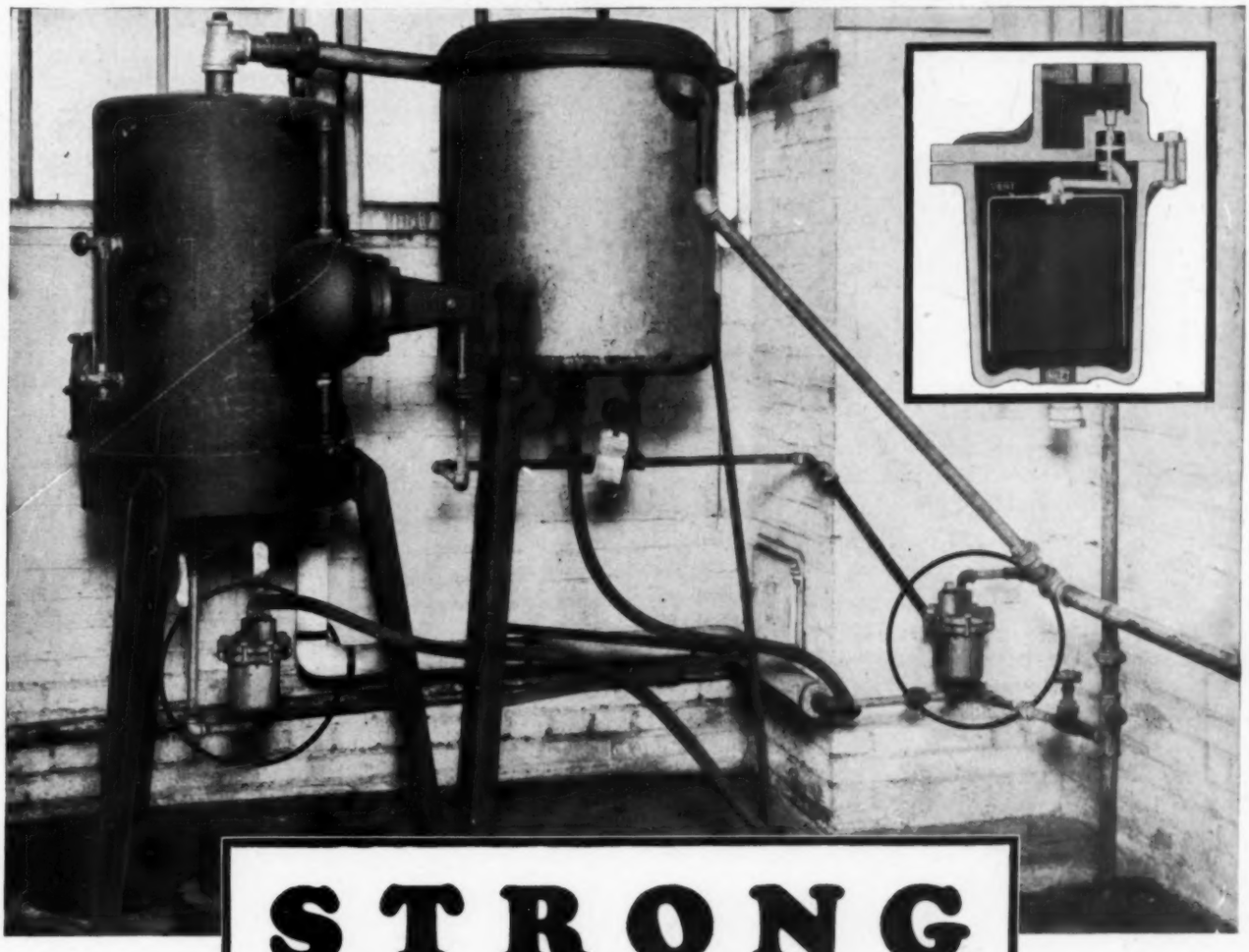
CHICAGO, 2720 Greenview Ave. NEW YORK, 137 E. 46th Street

Offices in 37 other cities

Strong traps on a water still

A METROPOLITAN bakery, the J. Spang Baking Company, operates a huge fleet of electric delivery trucks which require large quantities of distilled water for their batteries. To insure a plentiful supply, the Spang bakery installed a water still with two Strong (20 Series) *inverted bucket* steam traps to drain condensate. Still and traps are shown, used eight hours a day.

With all working parts including valve seat and disc made of *ANUM-METL,* an almost indestructible alloy, Strong *inverted bucket* traps insure positive intermittent drainage of condensate with the minimum cost of maintenance for years to come. Strong traps cannot air-bind or wire-draw. They are unqualifiedly guaranteed tight for one year regardless of pressures or temperatures.

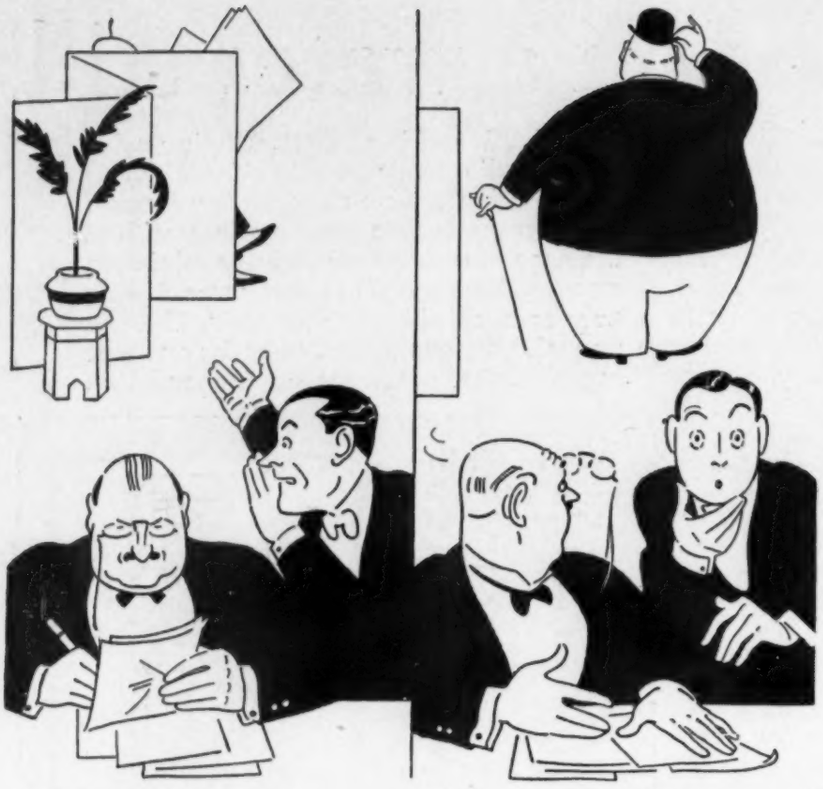


STRONG CARLISLE & HAMMOND

Among Strong steam specialties are Strong Steam Traps, Radiator Traps, Vacuum Traps, Pump Governors, Reducing Valves, Separators, Non-Return Valves.

3-Way Emergency Valves, Engine Stops, Instantaneous Closing Valves, Combined Throttle and Quick-Closing Valves, Balance Throttle, "EVR-TYTE" Globe Valves.

MANUFACTURERS OF STEAM SPECIALTIES · CLEVELAND, OHIO



"He's a six-footer" . . . . "Measured which way?"

Can figures be facts if they are wrongly arrived at?

In considering performance of heating systems, no analysis or comparison based on hasty acceptance of inaccurate measurements or of incomplete facts, can be safe, or useful.

Unless *all* the factors which may influence the result have been checked, to speak of, for example, "lbs. per sq. ft. per season" means just as little as to say "twice as long as a piece of string."

Altogether there are 45 of these variable factors,—each of which may affect the requirements and results for better or worse. To allow any one of them to be forgotten or disregarded may lead to faulty conclusions.

Engineers, architects and heating contractors will find the related subjects of heating steam consumption analysis, estimating and heating cost accounting, as presented by Warren Webster & Company, of vital interest.

A request for further details will bring a Webster steam heating specialist to discuss this vitally important subject.

A Heating System for Every Need and Every Purpose

Heating requirements vary so widely that no one type of heating system can be expected to provide the greatest return on the dollar invested in the heating equipment for all types and sizes of buildings. Realizing this, Warren Webster & Company have consistently developed an entire group of Webster Systems of steam heating to provide *a heating system for every need and every purpose.*

Webster MODERATOR System provides "Controlled - by - the-Weather" heating and makes possible new methods of operation and new standards of economy. Can be applied to any existing steam heating system of sufficient size.

IMPROVED Webster Vacuum System provides distribution balanced from the start—the supply of steam to each radiator is so equalized that all radiators get steam at the same time and in substantially the same proportion, regardless of distance from the boiler. May be supplemented by HYLO Vacuum Variator, permitting manual control by building operator. Applicable to new or existing installations.

IMPROVED Type "R" System for residences and larger buildings as well, combines advantages of steam heating with advantages of hot water, but without limitations. Meets fully the operating requirements of newer fuels, newer types of radiation and newer thermostatic controls. Also provides better-than-ever heating service with old radiation and old controls.

Full details of any or all of these systems will be furnished on request.

Warren Webster & Company, Camden, N. J.
Pioneers of the Vacuum System of Steam Heating
Branches in 60 Principal U. S. Cities
Darling Bros., Ltd., Montreal, Canada

-since 1888
Webster
Systems of Steam Heating
a155

This is one of a series of advertisements discussing the factors affecting heating steam consumption. The purpose of the series is to call attention to the methods of heating steam consumption analysis, estimate and heating cost accounting developed by Warren Webster & Company to provide a reliable basis for comparing heating system efficiency. Actual detailed facts and figures of steam consumption of a number of Webster Systems of Steam Heating, prepared in accordance with these methods, are available for your examination.

DART UNIONS

When you visit the National Power Show stop at Booths 232-233 and ask to be shown a DART UNION. TAKE IT APART. You will be able to see at a glance the TWO BRONZE SEATS, how they seat perfectly and why they are bound to hold when once made up. Ask also about the application of DART UNIONS for all power piping. It's information well worth having.

E. M. DART MANUFACTURING CO.
PROVIDENCE, RHODE ISLAND
THE FAIRBANKS CO., New York — Sole Distributors

FAIRBANKS
SPHERO VALVES

Fairbanks SPHERO VALVE, 4-in., 6-in. and 8-in. sizes, are worm and gear operated, and can also be arranged for remote control through the use of extension shafting. Available in any metal that can be cast.

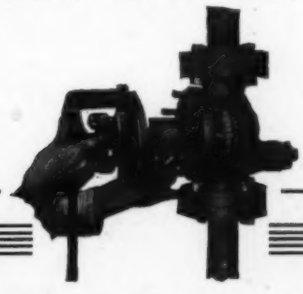
Booths 232 - 233
NATIONAL POWER SHOW
Grand Central Palace, New York
Dec. 1st to 6th

Now you will have the opportunity of seeing the NEW SPHERO VALVE in OPERATION. You will see how easily repairs can be made to the SPHERO WITHOUT REMOVING THE BODY FROM THE LINE.

If you cannot get to the Show write us for full details.

Write for Descriptive Bulletin V-103

Fairbanks SPHERO VALVES ½-in., ¾-in., 1-in., 1¼-in., 1½-in., 2-in., 2½-in., 3-in. and 4-in. sizes are wrench operated. Available in any metal that can be cast.



INSPECT—— ——EASILY

THE FAIRBANKS COMPANY
Distributors Everywhere
Boston New York Pittsburgh

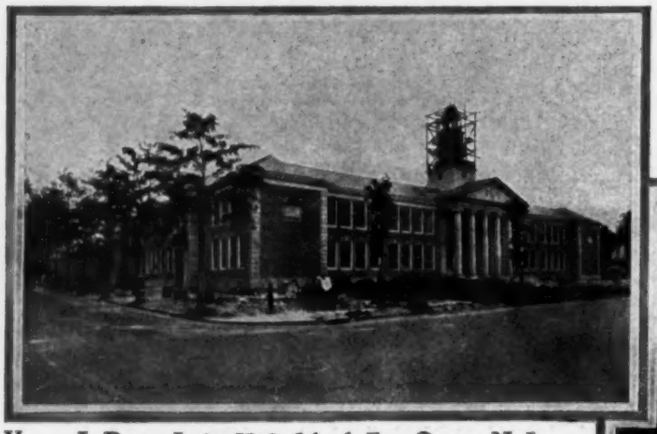
BUCKEYE Heatovent

Four More of New Jersey's Modern Schools

adopt

Buckeye Heatovent Modern Ventilation

The Unit System of Heating and Ventilating



Vernon L. Davey Junior High School, East Orange, N. J.
Contractor: Frank P. Farrell, Newark, N. J.
Architects: Guilbert & Betelle, Newark, N. J.

High School, Milburn, N. J.
Contractor: N. F. Cantello, Elizabeth, N. J.
Architects: Guilbert & Betelle, Newark, N. J.

Washington High School, Ridgewood, N. J.

High and Grade School, Somerville, N. J.
Contractor: Elling Bros., Grove Street, Somerville, N. J.
Architect: J. Noble Pearson & Son, Perth Amboy, N. J.

Fresh Air-Filtered Air-Warmed Air-Diffused Air in Every Classroom

THE BUCKEYE BLOWER COMPANY

Main Office and Factory — *400 Dublin Avenue Columbus, Ohio*

Sales and Service Offices

ATLANTA	CHICAGO	DETROIT	KANSAS CITY, MO.	NEWARK	RICHMOND, VA.	SPOKANE	TULSA, OKLA.
BALTIMORE	CLEVELAND	GRAND RAPIDS	LOS ANGELES	NEW YORK CITY	SALT LAKE CITY	ST. LOUIS	YOUNGSTOWN
BOSTON	DALLAS	HARRISBURG, PA.	MILWAUKEE	PHILADELPHIA	SAN FRANCISCO	SYRACUSE	Canadian Office
BUFFALO	DENVER	INDIANAPOLIS	MINNEAPOLIS	PITTSBURGH	SEATTLE	TOLEDO	TORONTO

The NITRALLOY movement of this Gauge

The Ashcroft American Duragauge is made in sizes from 4½" to 16", for all pressures up to 5000 lbs., in Wall Mounted case, Flush Mounted and Flush Mounted Illuminated cases.

. . . outlasts a Hundred others

SIX months ago the nitralloy movement of one of our new Ashcroft American DURAGAUGES was connected to a small compressed air hammer vibrating at about 1500 cycles per minute. At the same time the movement of a commercial gauge was attached to the same hammer in the same way.

The hammer has been vibrating 24 hours a day ever since. The nitralloy movement still shows no sign of wear, but the other gauge movement has been replaced successively by a hundred others . . . . including movements taken from every make of gauge. The average length of life of an ordinary bronze movement was 75 minutes under this severe test. By that time the teeth were worn almost bare.

These movements have, in every instance, literally gone to pieces before being replaced . . . . but the new Ashcroft American nitralloy movement remains in perfect condition.

Frankly, we don't know how long it *will* last! But consider what this means to you . . . . here at last is a gauge with a practically indestructible movement; a gauge that is made to last forever.

The Ashcroft American **DURAGAUGE** is unconditionally guaranteed for five years, and to be accurate within one-half of 1% over the entire scale range. Such a gauge could only be produced by a Company with a background of eighty years of gauge manufacturing experience. Write today and get the complete story.

CONSOLIDATED ASHCROFT HANCOCK CO., INC.
Bridgeport, Conn.
Subsidiary of Manning, Maxwell & Moore, Inc.

CONSOLIDATED ASHCROFT HANCOCK

ASHCROFT AMERICAN DURAGAUGE

Specify Catalogs Desired:

American Dial Thermometers	G-63	American Recording Gauges	E-63	Consolidated American Safety and Relief Valves	Z-63
American Glass Thermometers	F-63	American Draft Gauges	B-63	Hancock Bronze Valves	WB-63
American Recording Thermometers	H-63	American Gauge Testers	D-63	Hancock Cast Steel Valves	WA-63
Ashcroft American Gauges	A-63	American Tachometers	J-63	Hancock Forged Steel Valves	W-63
American Temperature Controllers	R-63	Ashcroft Power Control Valves	M-63		

AUTHORITIES ON HEATING, COOLING AND AIR CONDITIONING
Original Research, Skilled Engineering, Complete Facilities, Large Production, Field Inspection.

The touch of AUTHORITY

You find it *somewhere* in every field of endeavor: in the singing tone of a Stradivarius; in the inspired work of a great architect; in the design of industrial equipment. The touch of Authority is unmistakable in attainment of every sort.

Hundreds of devices are made to heat, cool or condition the air in industrial plants. But as in all other things, the authoritative design, the engineered construction, the master touch which assures superlative performance is found in very few.

Behind York Products are years of *original research*. As a result, York has been able to apply most effectively the natural laws of air travel to the field of heating, cooling and air-conditioning.

Through *engineering precision* York has developed the pioneer equipment of ten years ago into the present-day, highly perfected York Heat-Diffusing Unit which embodies the oftentimes slight, but important, differences in structural design that distinguish York performance from the commonplace and keep operating expenses low.

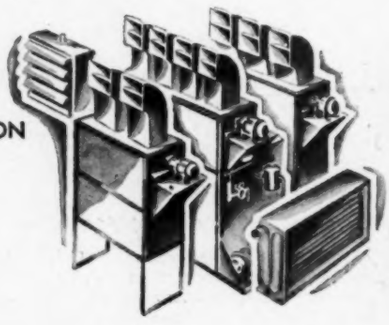
Technically trained and thoroughly experienced York engineer-salesmen are located in York Branch Offices in principal cities everywhere. They will be glad to consult with you on any problem relating to heating, cooling or conditioning your plant. York Heating & Ventilating Corporation, 1575 Sansom St., Philadelphia.

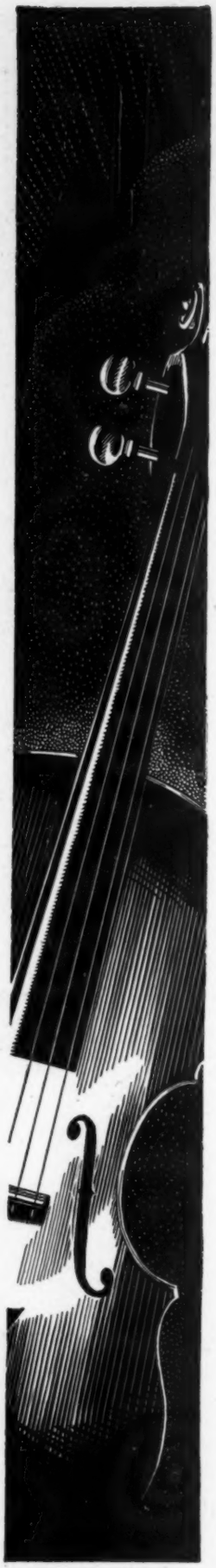
YORK HEATING AND VENTILATING CORP'N

LEADERS IN THE FIELD OF UNIT MANUFACTURE

PHILADELPHIA *Branches in all principal cities*

HEAT-DIFFUSING UNITS
AIR-CONDITIONING UNITS
KROY AIR COOLING UNITS
SUPER-FIN FAN BLAST RADIATION





SCIENTIFIC HEAT CONTROL FOR LARGE BUILDINGS BY THE OUTDOOR TEMPERATURE

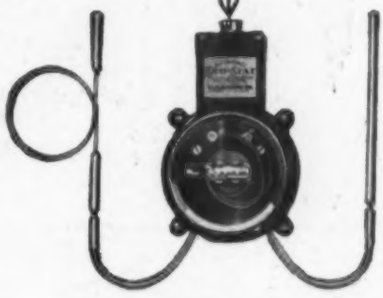
NOW MADE POSSIBLE WITH SIMPLE APPARATUS AT LOW COST

CONSUMERS BUILDING
and CENTURY BUILDING
Chicago

Each of the buildings shown above is equipped with a DUO-STAT control system the same as shown in this advertisement.

The DUO-STAT operates from a combination of both the Outdoor and Radiator Temperature. One is made to balance the other; thus heat is supplied to a building only as fast as the building is losing heat. There can be no overheating.

In the Consumers Building, shown at the left, a DUO-STAT reduced the steam consumption almost 50%.



TYPE C-2 DUO-STAT

The Master Control Instrument

Only one DUO-STAT is required to control the entire heating system and is located near the last radiator on the longest steam line.

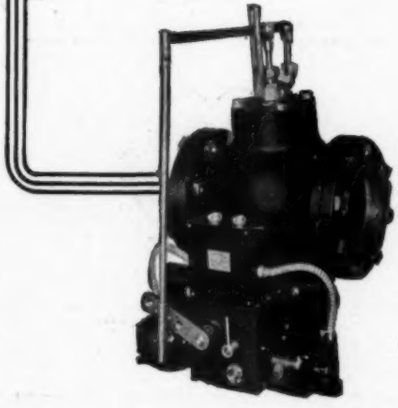
THREE-WIRE CONTROL CIRCUIT

CONTROL PANEL

The Control Panel is usually located in the Engineer's office. From this panel the main steam valve may be controlled manually, when desired.

MAIN STEAM VALVE

Shown below is the motor-operated main steam valve that controls the steam supply to the entire heating system. This valve is operated automatically by the DUO-STAT.



STEAM SAVINGS 25 TO 40%

Reports from all over the country indicate steam savings in all types and sizes of buildings under DUO-STAT control average approximately 25%, and in many cases as high as 50%. Even though you are using thermostats or other forms of control at the present time, a DUO-STAT will reduce your steam consumption with a more uniform and satisfactory heat to the tenants.

DUO-STAT control does not require a special type of heating system, but will efficiently control any one-pipe or two-pipe heating plant. We will gladly analyze your heating problem for you.

F. I. RAYMOND COMPANY
629 West Washington Blvd. - CHICAGO

Write for Bulletin No. 3 which describes this unusual apparatus

.....

.....

HEATING AND VENTILATING ARE AN IMPORTANT PART OF MANUFACTURING

Are your workmen handcuffed with cold?

Workmen — whose fingers are numb — whose heads are clogged up — whose dispositions are ruined by cold — are inefficient. They make mistakes. Often they are laid up at home with ailments brought on by their faulty working environment.

Inefficient employees are a drain on profits. Mistakes cost money. Absent workmen mean idle machines. When machines stand idle production schedules are ruined and profits vanish. Skinner Bros. Unit Heaters insure conditions conducive to maximum production.

The Skinner representative in your city will be glad to discuss your heating, ventilating or air-conditioning problems with you without obligating you in any way. Telephone him today or write direct to Skinner Bros. in St. Louis, outlining your problems.

Skinner Bros. Unit Heaters

SKINNER BROS. MANUFACTURING COMPANY, Inc.
1402 S. Vandeventer Avenue, St. Louis, Mo.
Branches in All Principal Cities *"The Originators of Unit Heating"*

A UNIT HEATER FOR EVERY INDUSTRIAL HEATING AND VENTILATING REQUIREMENT

Skinner Bros. "Boots Patent" Air Heater

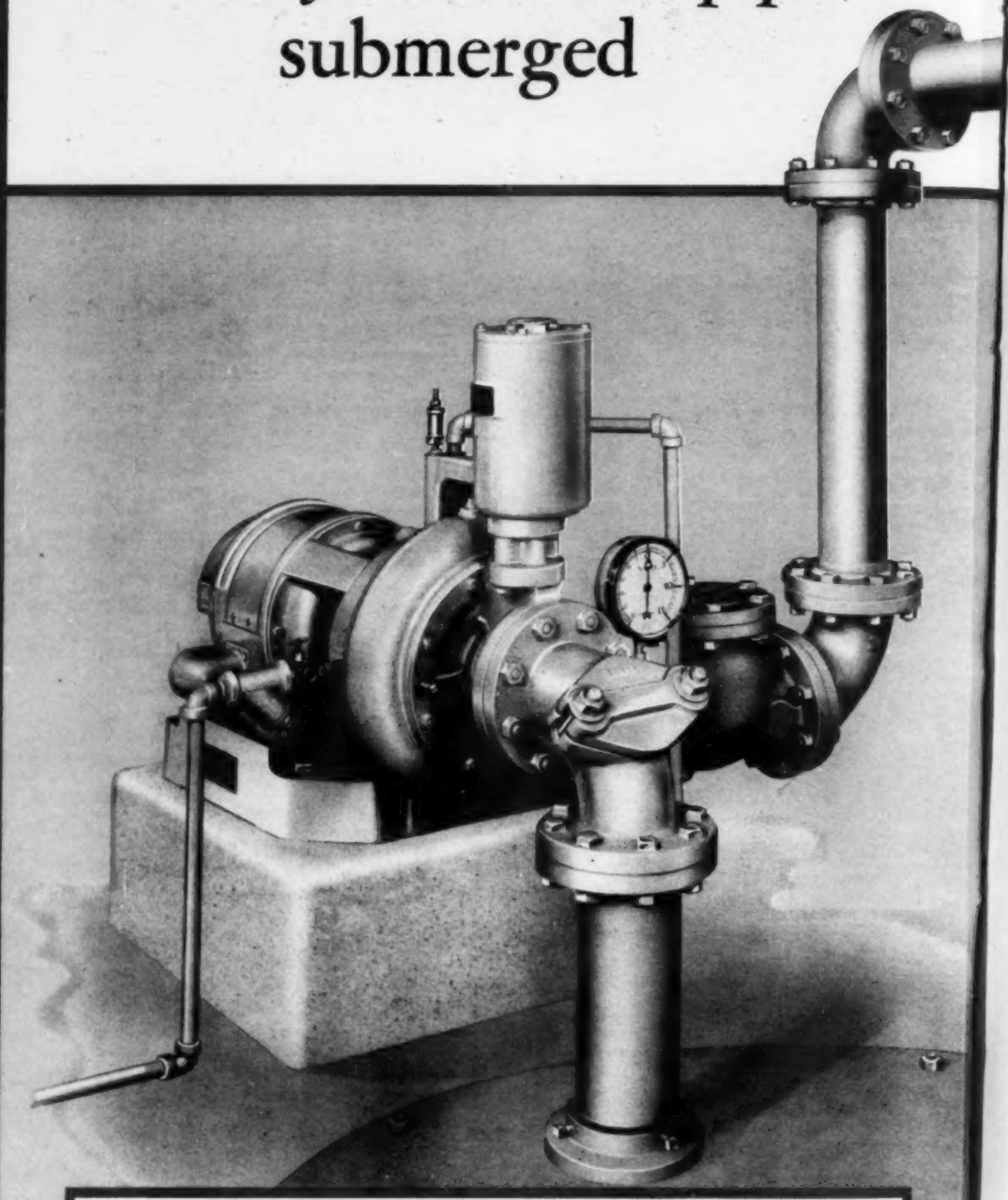
Skinner Bros. Patented Direct-Fired Air Heater

Skinner Bros. Patented "Lightweight" Air Heater

Skinner Bros. Type "U" Air Heater

Why
go down like a fish!

A Jennings Sewage Pump *has only the suction pipe* submerged



You can inspect or clean a Jennings *right out on the floor*

CONVENIENCE is the outstanding feature of a Jennings. There is nothing awkward about getting at this sewage pump. The entire assembly is installed on the floor, outside the pit. Nothing is submerged except the suction pipe.

With every working part so accessible, easy work is made of inspection and cleaning. Opening up the pump and even removing the impeller takes only a few minutes. Neither pit cover, piping nor shaft alignment need be disturbed.

Jennings Suction Sewage Pumps are furnished in capacities and heads to meet all the usual requirements. All sizes are equipped with non-clog impellers. No screens are required.

Write for Bulletins 113 and 124.

NASH ENGINEERING COMPANY
33 Wilson Road, South Norwalk, Conn.

Jennings
SUCTION
SEWAGE
Pumps

Note these 10 *features of Jennings Design*

1. Motor is commercial, ball-bearing type selected for dependability, always available from stock.
2. The only two moving parts are mounted on a single heavy shaft requiring but one stuffing box, eliminating flexible coupling.
3. A rugged supporting bracket, integral with motor end shield, makes pump and driving motor a single compact assembly in perfect alignment.
4. The non-clog impeller is accurately balanced, liberally proportioned, readily reached.
5. There are only two bearings to lubricate.
6. Suction elbow is fitted with hand hole plate to permit cleaning suction pipe and impeller without dismantling pump.
7. Priming unit is a simple, sturdy Nash Hytor.
8. Iron catch basin has gas tight cover.
9. Controlling float switch is totally enclosed and oil immersed.
10. Ball float has adjustable stop.

Oxwelding Has Become Standard Practice

Architects and engineers have been quick to appreciate the inherent advantages of oxwelding as applied to modern piping services. On its record of proved performance, this method of pipe jointing has gradually become the standard practice in many fields and is constantly gaining further recognition. In high pressure work it is the only means of satisfactory construction at moderate cost.

Oxwelded joints are as strong as the pipe itself and equally resistant to corrosion. Consequently lighter-walled pipe may often be used for the entire system, thus effecting a material saving in total weight. Headers, for instance, which formerly required a particularly large number of cast fittings, are fabricated by oxwelding very simply of standard sizes of pipe, and because of their relatively light weight require less labor for installation.

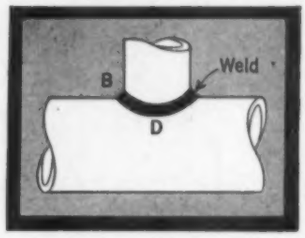
Under Procedure Control, welded piping construction may be undertaken with the same confidence in a satisfactory result as older methods, and with further assurance of increased economy and serviceability.

THE LINDE AIR PRODUCTS COMPANY...THE PREST-O-LITE COMPANY, INC....OXWELD ACETYLENE COMPANY
UNION CARBIDE SALES COMPANY...UNITS OF
UNION CARBIDE AND CARBON CORPORATION

General Offices . . . . . New York UCC Sales Offices . . In Principal Cities

DESIGN STANDARDS FOR OXWELDED PIPING

Any welded piping system, even in its most complicated form, is a combination of a few fundamental welding design details.



WELDED TEE AND BRANCH CONNECTIONS

Explanation of Design:

Welded tee fittings, crosses and branch connections, of either equal or unequal diameters, can be fabricated from standard pipe by cutting with the oxy-acetylene blowpipe and welding to form the finished fittings.

Uses:

Welded Tee and Branch Connections can be used for all sizes and services to replace standard or special fittings commonly used in piping systems.

Specification:

When Welded Tee and Branch Connections are specified, the following features should be included in the specifications:

1. Templets shall be used for making cuts.
2. Center lines shall be marked and matched in assembly.
3. When beveled with the blowpipe, the cut edges shall be thoroughly cleaned of slag before welding.
4. Cuts shall be carefully beveled and accurately matched in order to form a good vee for welding.
5. Welds shall be built up to a thickness of at least 1¼ to 1½ times the pipe wall thickness and form a gradual fillet between the branch and header.
6. The weld shall be of sound metal free from laps, gas pockets, slag inclusions or other defects.

The above is excerpted from a handbook of fundamental designs, titled "Design Standards for Oxwelded Steel and Wrought Iron Piping," published by The Linde Air Products Company. A copy of this handbook should be in every architectural drafting room. It is yours for the asking. Just fill in and mail the coupon.

Technical Publicity Dept., 12th Floor
205 East 42nd St., New York, N. Y.

Please send me a copy of your new book, "Design Standards for Oxwelded Steel and Wrought Iron Piping," which also explains procedure control for pipe welding. HPAC-12-30

Name.....

Company.....*Position*.....

Street Address.....

City.....*State*.....

Why DUNHAM Differential Heating was chosen for the Jackson Tower Building—

Jackson Tower, Jackson, Miss.

18-story building with 4-story tower. Rentable area, 60,000 square feet. Height, 263′ 10″.

Architect: C. H. Lindsley.

Consulting Engineers: Gardner & Howie (Memphis).

Heating Contractors: Paine Heating & Tile Co.

NO pains were spared to make the recently opened Jackson Tower Building one of the most modern and attractive office buildings. At the same time it is designed to be a paying investment.

Dunham Differential Heating was chosen because it ideally fits in with these considerations. This outstanding engineering development in control and application of steam for heating cuts fuel costs and keeps tenants comfortable by elimination of overheating. This feature is particularly suited to the climatic conditions of the South. Fuel savings of 25 to 40% have been demonstrated by installations in all types of buildings, including the largest of office, commercial and apartment buildings.

Heating costs may also be cut on existing systems. Plants can often be changed over to Differential Heating by a simple and convenient alteration, the cost of which is paid out of fuel savings. Why not have Dunham engineers survey your present system, free of charge, and give you an estimate of the savings possible?...or work with your heating contractor on new installations.

C. A. DUNHAM CO.

Dunham Building, 450 E. Ohio St., Chicago, Ill.

Over 80 branch Offices in the United States and Canada bring Dunham Service as close to you as your telephone. Consult your local directory

Dunham Engineers are at your service with complete and authoritative data on improved heating to meet your individual requirements

Look for the name DUNHAM. The name-plate identifies a genuine Dunham Thermostatic Radiator Trap

EASIER *and* E-A-S-I-E-R!

THE photo below shows an off-set in a branch from main steam line, inserted to clear 12″ compressed-air line which has not yet been installed.

Notice two things: The compound turn *easily* fabricated from Tube-Turns, the stock fittings for pipe welding—

And the ease with which the insulation will be put around the smooth, even surfaces of the entire *welded* job!

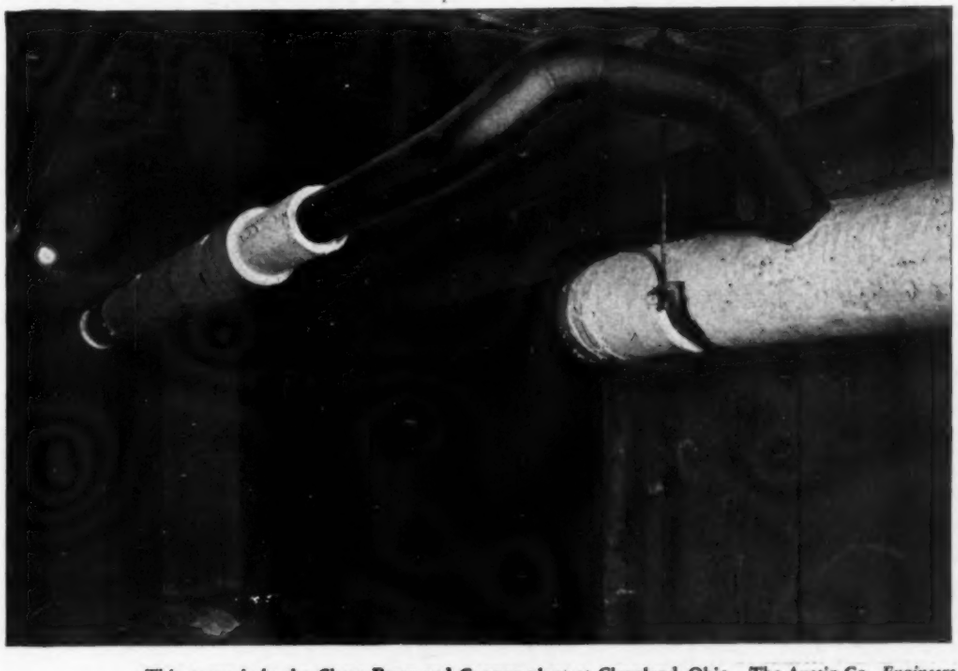
What TUBE-TURNS Are — and *DO*

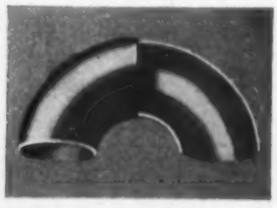
Tube-Turns are short-radius fittings for pipe welding, *forged* from seamless tubing. They are uniform in wall-thickness—no thinning of outside wall, no thickening or buckling of inside wall. They have a full, round cross-section—*less pressure drop.*

Tube-Turns speed the designing, estimating and installing of all piping. They are placed in the line with only *two* welds—each straight across the pipe. They are much stronger, much lighter, much easier to insulate. They eliminate maintenance and service calls for the contractor

—and can usually pay for themselves by savings in erection costs alone. Big claims, but easily proved—IF you say the word.

Address: TUBE-TURNS, *Incorporated,* 1309 South Shelby Street, Louisville, Ky.





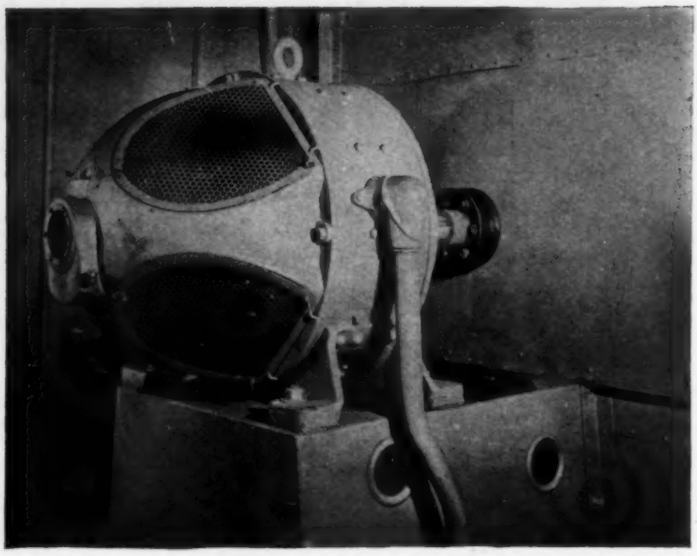
TUBE-TURNS are made in 45°, 90° and 180° types, in 1″ through 18″ Standard I. P. S., and 1½″ through 12″ Extra-Heavy I. P. S. . . . Standard radius is 1½ times nominal pipe diameter. . . . *Stocked* by distributors in principal cities.

This scene is in the Chase Brass and Copper plant at Cleveland, Ohio. The Austin Co., *Engineers and Constructors;* The Smith & Oby Co., *Piping Contractors.* . . . Write today for a complete cost-analysis of one of the nation's most interesting jobs, in which welding *and Tube-Turns* were employed. Gladly sent you, without obligation, *on request!*

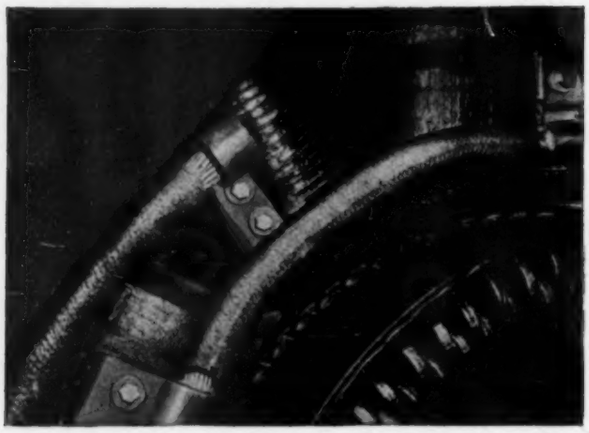
TUBE-TURNS

No Buckling of Inside Wall—No Thinning of Outside Wall

ELECTRICAL LUNGS *move tons of air*



Forty of these SK-powered Buffalo Forge fans circulate fresh air in the Chicago Civic Opera Building.



Mica and Micarta insulation. One of the long-life features of Westinghouse motors.

A CIRCULATION of several tons of fresh air per minute in many of today's buildings is necessary for the health and comfort of the occupants. It takes more than *just another motor* to serve this program year in and year out, without a shutdown.

Long-lived insulation is one of the features built into Westinghouse motors which makes them so dependable. Amber mica and Micarta protect the current carrying parts within the motor. At all times, these heat and moisture resisting materials fortify the power end of the ventilating and pumping systems. They enable Westinghouse motors to meet the requirements of sustained operation with negligible attendance and upkeep expense.

A call to our nearest office will bring you Westinghouse complete engineering service for solving any of your building electrification problems.

Service, prompt and efficient, by a coast-to-coast chain of well-equipped shops

Westinghouse

T 31621

TUNE IN THE WESTINGHOUSE SALUTE OVER THE N. B. C. NATION-WIDE NETWORK EVERY TUESDAY EVENING.

Magnificence at its Height

THE new Waldorf-Astoria is truly "magnificence at its height". Arising from traditions rich in association with famed personages from all countries of the globe . . . this renowned hostelry achieves new splendor in size, decoration and equipment. Infinitely more commodious than its predecessor whose name it bears, the magnificent new Waldorf-Astoria is planned to be the center of hospitality for a modern world.

Naturally in so fine a structure every piece of mechanical equipment must bear the closest scrutiny—the piping systems will be the "last word"—the major tonnage will be NATIONAL—

America's Standard Wrought Pipe

The New
WALDORF-ASTORIA
New York City

Architect: Schultze & Weaver
Consulting Engineer: Clyde R. Place
General Contractor: Thompson-Starrett Co.
Plumbing Contractor: John McMillan Co.
Heating Contractor: Thompson-Starrett Co.

NATIONAL PIPE

NATIONAL TUBE COMPANY

Burnham Boilers

This New Sectional Burnham Boiler Successfully Meets Smoke Codes

When you have strict smoke ordinances to observe, you need no longer forego the practical advantages of cast iron boilers, to meet their requirements.

The fuel thrifty Water Tube Type Cast Iron Burnham Boiler, 36-inch Series, now comes with a special back section, arranged to introduce air at the back of the primary combustion chamber. The unburned material in the smoke is ignited, just as it enters upon its long fire travel.

With the most volatile grades of soft coal, this boiler is smokeless, within the limits of any municipal ordinance.

Catalog giving description, rates and measurements will be sent on request.

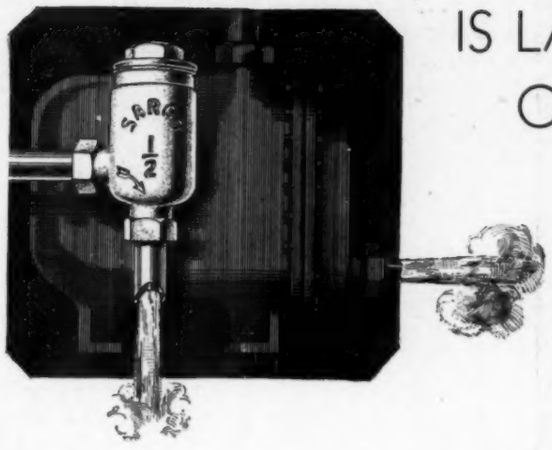
Burnham Boiler Corporation

IRVINGTON, NEW YORK

New York Office: Graybar Building, 420 Lexington Avenue

Representatives in many principal cities of the United States and Canada

NO STEAM TRAP



IS LARGER THAN THE CAPACITY OF ITS DISCHARGE VALVE

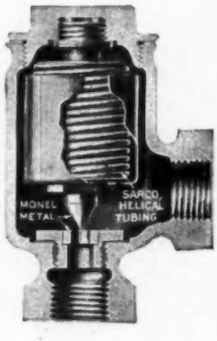
DO not be misled by the bulk of cumbersome float or bucket traps. They cannot remove condensate faster than the water will pass thru their pin-hole orifices.

The Sarco needs no pool in which to swim a float, nor does it waste time by waiting to fill and empty a bucket. It discharges condensation continuously, as fast and long as it forms.

That's why it is one-third the size and one-third the price of other traps. Sarco takes up no more space than a street ell.

Has only one moving part, the thermostatic element, which operates on a slight difference in temperature between water and steam. Sarco is self-adjusting for all pressures up to 100 lbs.

Over one million have been sold. A trial will convince you. USE THE COUPON.



SARCO COMPANY, INC.
183 Madison Ave. New York, N. Y.

Branches in Principal Cities

Walker, Crosweller & Co., 20 Queen Elizabeth St.
London S. E. 1

See Our Exhibit Booth 33 Power Show

SARCO STEAM TRAP

SARCO CO., INC.
183 Madison Ave., New York, N. Y.

- ☐ Send a Sarco Steam Trap on 30 days' free trial.
  Size ..... for pressure ..... lbs.
- ☐ Send Booklet No. O-95

Firm.....

Street.....

City..... State.....

Complete piping in the new A. E. Staley power plant at Decatur, Illinois, was furnished by Limbert

DIFFICULT PIPING MADE TO FIT

Limbert facilities for doing the hard jobs in high pressure, high temperature piping and fittings are unequalled. Every type of high pressure joint is in regular production. Facilities for any fitting, cast or welded, are at hand. The most difficult types of bends and welded work are regular jobs for Limbert.

Limbert engineers will gladly assist you in the design and specification of your difficult piping. They can give you the benefit of a third of a century of pipe fabricating experience. They have a background of installations made in refineries and power plants the world over. You can depend on Limbert to handle your hardest job in a way that will save time and installation expense.

Use Limbert to manufacture ordinary requirements, or to design and manufacture special piping for any refinery condition.

GEO. B. LIMBERT & CO.

570 Fulton Street, Chicago, Illinois

Works: East Chicago, Indiana

St. Louis, Mo.:
356 Paul Brown Building

Kansas City, Mo.:
1336 Oak Street

Detroit, Mich.:
825 Washington Blvd. Building

LIMBERT PIPING

SERVICE THAT IS WITHIN 24 HOURS OF WHERE YOU ARE

Johnson Service Company maintains thirty branches on the North American continent: one in each of the twenty-five largest and geographically best situated cities in United States, and five likewise in Canada.

Each branch is Johnson *Service* Company; not an agency, dealer or contractor, but thoroughly *Johnson*.

Whatever the requirement, wherever the job is located, Johnson "Service", with direct attention by Johnson Company personnel, is available within twenty-four hours time.

In addition to this immediate service attention, each installation receives Johnson inspection annually.

This indicates the continued interest given by this company in the service of its system and apparatus.

JOHNSON SERVICE COMPANY 149 EAST MICHIGAN MILWAUKEE, WISCONSIN

Albany	Chicago	Des Moines	Los Angeles	Portland	Calgary, Alta.
Atlanta	Cincinnati	Detroit	Minneapolis	St. Louis	Montreal, Que.
Baltimore	Cleveland	Greensboro, N. C.	New York	Salt Lake City	Winnipeg, Man.
Boston	Dallas	Indianapolis	Philadelphia	San Francisco	Toronto, Ont.
Buffalo	Denver	Kansas City	Pittsburgh	Seattle	Vancouver, B. C.

ESTABLISHED 1885

Union Gas & Electric Company Building, Cincinnati, Ohio

Architects:
Garber & Woodward . . . . . Cincinnati
John Russel Pope . . . . . New York City

Fosdick & Hilmer . . . . . Consulting Engineers

200 Johnson Dual Thermostats control 532 radiator valves in Union Gas & Electric Company Building: maintaining normal temperature during the day, automatically lowering the temperature for the night, and automatically returning the temperature to normal again each morning. In addition, this installation includes Johnson system fan control and Johnson cut-off fresh air and vent dampers on the building's ventilating system.

The All-Metal System. The All Perfect Graduated Control of Valves and Dampers.

The Dual Thermostat (Night & Day) Control: Fuel Saving 25 to 40%.

JOHNSON HEAT AND HUMIDITY CONTROL

CARRIER ANNOUNCES

GREAT CHANGES are under way in the business of air. Railroad diners were successfully air-conditioned for the first time this year. Quick-freezing of foods and their preservation for marketing have raised a host of new problems in refrigeration. Extensive factory remodeling has stirred a widespread interest in unit-heating.

To cope successfully with these rapidly changing conditions—to offer architects, engineers, manufacturers, and owners the most recent and most authoritative information in the allied fields of heating, cooling, refrigeration and air-conditioning—the Carrier Corporation has been formed.

Three companies are combined in the new corporation. Each has back of it years of pioneering, research, development and service.

The engineers of the Carrier Engineering Corporation have pioneered the development of air-conditioning for industrial and comfort uses for more than a quarter of a century. Their record of more than 3000 installations of Manufactured Weather in more than 200 types of business is evidence of their success.

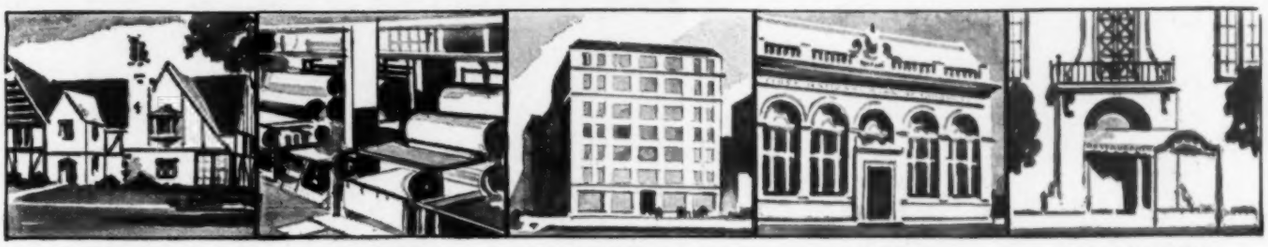
The Brunswick-Kroeschell Company has been developing and perfecting refrigeration equipment since the days when ice was the only refrigerating method accepted.

The York Heating & Ventilating Corporation has been a leader in the now widespread practice of using unit-heaters for factory heating.

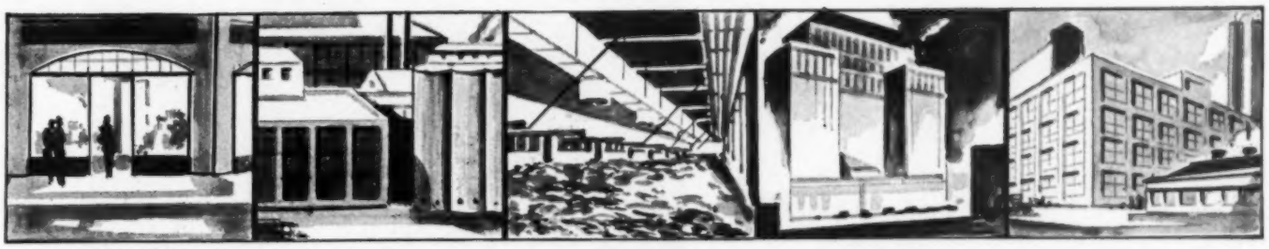
The Carrier Corporation merges the engineering resources, research and manufacturing of these three companies. It joins under unified management three manufacturing, sales and service organizations prepared to pass on to architects, engineers, building owners and industries, the multiple benefits of such consolidation. Carrier Corporation, Newark, N. J. Branches in principal cities throughout the world.

Carrier Corporation

Weathermakers to the World



A NEW *world-wide service*



in Air Conditioning

UNIT-HEATING AND COOLING AND REFRIGERATION

The Carrier Corporation combines

CARRIER ENGINEERING CORPORATION

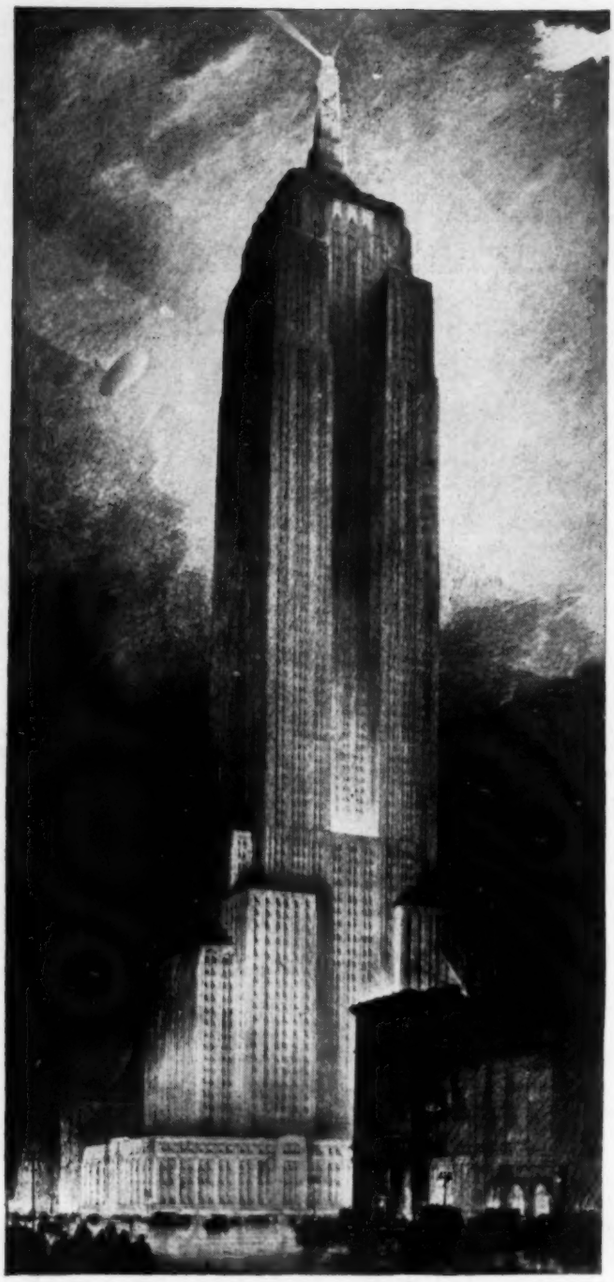
Originators of Manufactured Weather for weather-sensitive manufacturing processes in more than 200 types of industry and for personal comfort in more than a dozen varied business fields. Makers of Carrier Centrifugal Refrigeration Machines, Driers and Vapor Degreasers. The Carrier Engineering Corporation either controls or has an interest in the Carrier Construction Company, the W. J. Gamble Corporation, the Leather Equipment Company, Inc., the Carrier Engineering Company, Ltd., of London, the Carrier-Ross Engineering Company of London, the Cärrier Lufttechnische Gesellschaft of Stuttgart and the Carrier-Lyle Corporation, which offers the Weathermaker for the home.

BRUNSWICK-KROESCHELL COMPANY

Makers of refrigeration machines for all kinds of business and industry. Leading maker of marine refrigeration equipment, having equipped more than 3000 American ships.

YORK HEATING & VENTILATING CORPORATION

Pioneer makers of York Heat-Diffusing Units for all types of industrial plants and factories. Makers of York and Kroy Air-Cooling Units.



Empire State Building, New York City. *President:* Hon. Alfred E. Smith. *Architects*: Shreve, Lamb & Harmon, N. Y. *Builders:* Starret Bros. & Eken, Inc., N. Y. *Engineers*: Meyer, Strong & Jones, N. Y. *Heating and Ventilating Contractors*: Baker, Smith & Co., N. Y.

EMPIRE STATE'S 85 stories will be "aired" by 52 Sturtevant Fans!

Here, on the historic southwest corner of 5th Avenue and 34th Street, the loftiest building yet undertaken now dominates New York's skyline.

Empire State is located, designed and equipped to attract leaders of business. It is centrally situated near all transportation lines, spaciously planned, and equipped with every comfort . . . including Sturtevant ventilation.

From the basements to the base of the tower, the air in this building will always be comfortable, healthful, refreshing. 52 Sturtevant Silentvane Fans will circulate 1,035,250 cubic feet of air a minute, every minute of the day!

Empire State is the latest addition to the distinguished list of New York's Sturtevant-equipped buildings . . . a list that includes the New York Life, Western Union, 40 Wall Street, and the Chrysler. Every construction enterprise, above or under ground, can be equipped with dependable Sturtevant apparatus exactly suited to the particular requirements.

Sturtevant
REG. U.S. PAT. OFF.
HEATING-VENTILATING AND POWER PLANT EQUIPMENT

B. F. STURTEVANT COMPANY

Main Offices: HYDE PARK, BOSTON, MASS. — CHICAGO, ILL., 410 No. Michigan Ave. — SAN FRANCISCO, CAL., 681 Market St. *Branch Offices in Principal Cities.* Canadian Offices at: Toronto, Montreal and Galt. Canadian Rep.: Kipp Kelly, Ltd., Winnipeg. Agents in Foreign Countries

The EDITOR'S PAGE

Heating · Piping and Air Conditioning

FROM ARTICLES IN THIS ISSUE

"The allowances required to cover manufacturing limitations and tolerances are a factor of increasing importance in determining the proper wall thickness as the pipe diameter decreases . . . in some cases of more importance than the internal pressure in the pipe . . . need arose for a modified formula . . ."—*J. J. Harman.*

" . . . and ventilation currents should be broken up in small units so as to leave the air in the room as homogeneous as possible."—*F. R. Watson.*

"Hence, it is advisable to question the size of the valve to choose in each case; the inquiry must state these four questions."—*"Open for Discussion."*

"From the standpoint of proper utilization and care of wood products, air conditioning is an all-important factor."—*W. LeRoy Neubrech.*

"In an effort to keep down the excess air in the products of combustion the boilers have tight steel casings outside of the brickwork. These have proved to be very desirable."—*Samuel R. Lewis.*

"Humidity regulators should be sufficient in number and so located as to limit variations in humidity throughout the department to a 'commercially good' basis of performance."—*"Open for Discussion."*

"In laying out the piping in any particular building, care was exercised to provide that the incoming water be directed toward the side of the building having the coldest exposure, thus balancing the radiation throughout the building."—*I. W. Summerlin.*

" . . . air currents at healthful temperature and humidity are not injurious except as they may serve to carry disease germs."—*John H. Ruckman.*

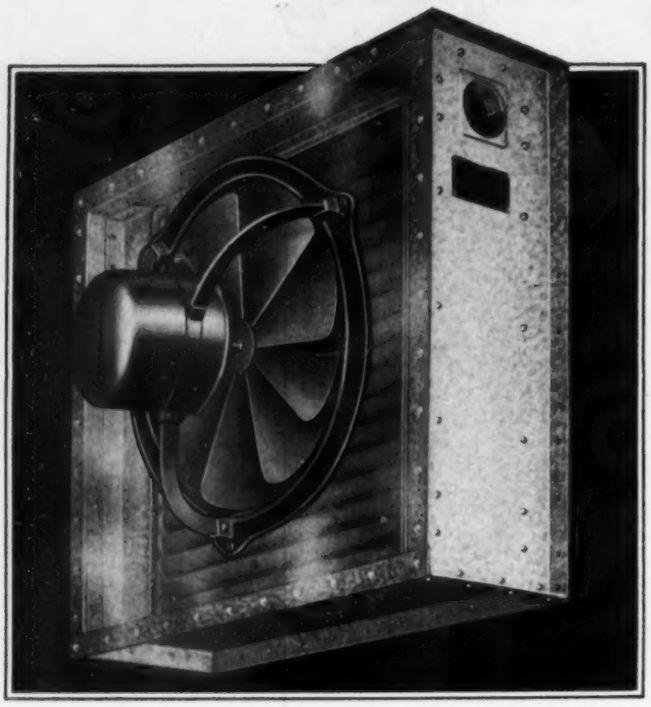
" . . . engineers are erroneously employing isothermal data in calculating fluid friction for the heating or cooling of fluids flowing in pipes."—*Temple C. Patton.*

" . . . the auditorium was supplied by a downward system of ventilation, . . . improving the acoustics by having the air flow toward the audience."—*Maria Sermolino.*

"I might take this opportunity to congratulate you on the high standards you have set so far and I intend to keep renewing my subscription as long as this standard is maintained. You have struck a happy medium between the extremes which exist in technical publications."

"I have been a subscriber to your magazine since its first issue, and consider it by far the best magazine in its field. The contributions by Sam Lewis are always interesting and I hope to see many more of them."

"HEAT WITH UNIT HEATERS"



of course!

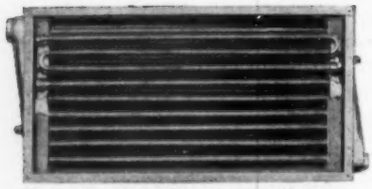
But whose to use?

Here's the answer!

To make sure that you select the right Unit Heater all you need do is make sure that THE HEAT-SURFACE IS

AEROFIN

(As standard for Unit Heaters as for all other Fan System Service)



The Standardized Light-Weight Fan System Heat-Surface

4 Types 196 Standard Sizes

Pressures up to 350 lbs. gauge

Unit illustrated in section is

Universal AEROFIN, *2½ to 200 lbs.*

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Newark will be glad to send informative and appropriate publications upon request.★

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AEROFIN is sold only by Manufacturers of Nationally Advertised Fan System Apparatus.

List upon Request

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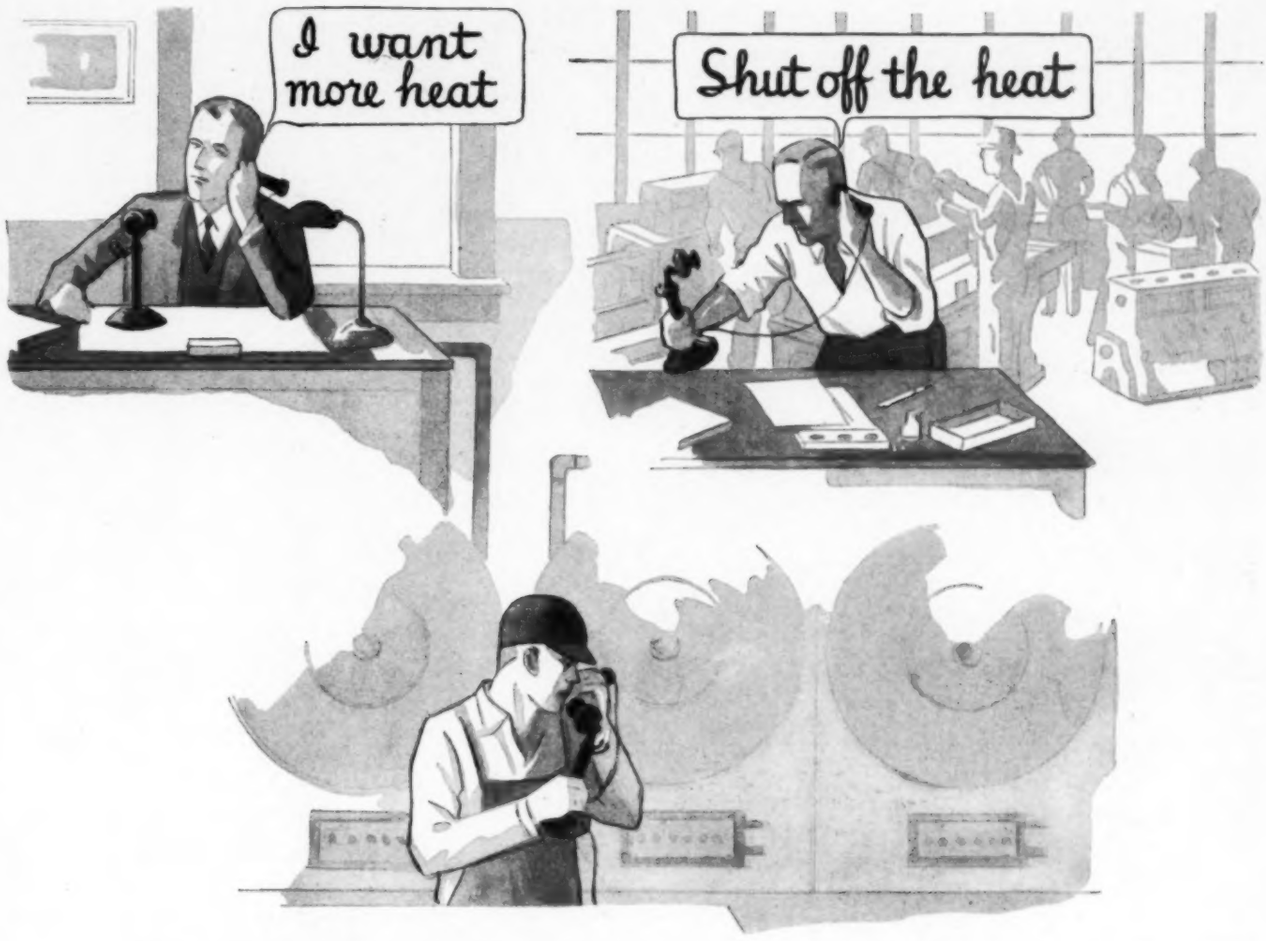


...and what can the poor engineer do?

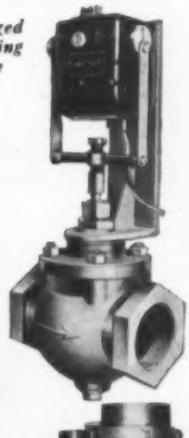
Precisely nothing—until a Minneapolis-Honeywell "tailor-made" system of heat control has been installed to regulate *each part* of the plant or building in accordance with *its* heating requirements.

For it's too much to expect one man, no matter how clever an engineer he may be, to regulate hand operated valves so that temperatures are right *and stay right.* And where a single system of control applies to the entire building the results are rarely satisfactory because the requirements in different departments vary so widely.

Minneapolis-Honeywell systems apply to direct radiation, indirect radiation and unit heaters, providing control individually or by groups or zones. They give you 72° in the offices, 65° in the shops, 50° in the warehouse, or any other temperatures your plant or building may require for maximum employee productivity and minimum fuel consumption.

Heat control engineering is as essential to the successful use of a building as architectural advice is for its original construction. The consultation service of Minneapolis-Honeywell heat control engineers is at your disposal without cost or obligation. Just mail in the coupon NOW for complete information.

Motorized regulating valve



Clock thermostat

Unifan control

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☐ Send me pamphlet on Unit Heater and Sectional Control Systems.
☐ Have representative call. I understand there is no obligation.

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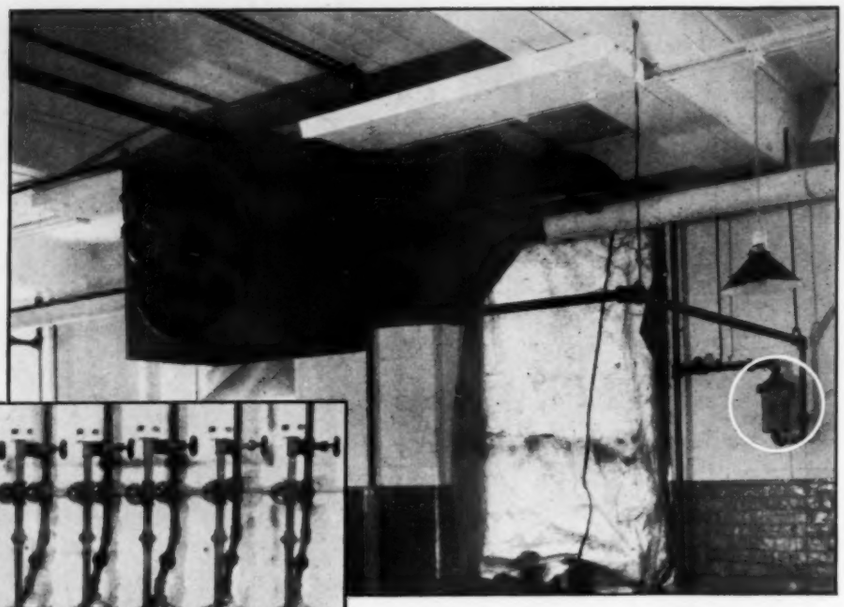
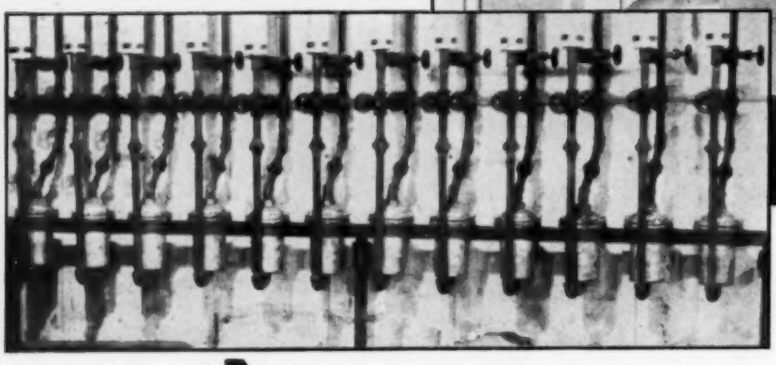
See our exhibit at the Ninth National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York, Dec. 1st to 6th.

Armstrong Trap keeping Sturtevant Unit Heater at highest efficiency — blanket mills, Maine Textile Company.



No condensate drainage troubles in this Ohio Match Co. plant: A battery of Armstrong Traps draining heating equipment.



nor do Armstrong Traps clog with scum or sediment

THERE is no surer way to secure dependable and positive condensate drainage from unit heaters, headers and coils than with Armstrong inverted bucket traps.

Armstrongs possess every qualification necessary for satisfactory performance. They can not airbind . . . nor do they clog up with scum or sediment. The upward-swirling movement of the condensate makes the trap self-scrubbing. Grease, scum and sediment go out with the discharge. These traps are giving attentionless service under conditions where other traps have to be taken off and cleaned frequently.

They have large capacity, yet are small and compact enough to be supported by connecting pipes. A No. 30 Armstrong trap, for instance, can easily be "palmed" in the hand. Steam leakage is prevented by the water seal. Chrome steel valves eliminate "wire-drawing."

Detailed information on their operation and applications sent on request. We cooperate with your engineers in determining trap sizes and efficient layouts.

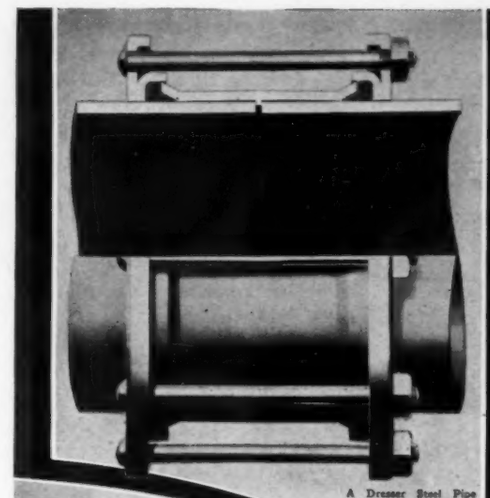
Armstrong Traps are furnished in sizes and types for pressures to 1350 lbs. and any degree superheat.

ARMSTRONG MACHINE WORKS
Three Rivers, Michigan
District Representatives in 42 Cities

HP&AC12—Gray

DRESSER COUPLINGS

STAY PERMANENTLY TIGHT

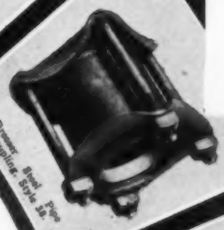


A Dresser Steel Pipe Coupling Style 38 sectioned to show principle of pack.

Dresser Steel Long Sleeve Style 40, sizes 2 in. I. D. to 3 in. I. D.

Dresser Steel Long Sleeve Style 40 in the smaller sizes.

Dresser Saddle, 2 clip.

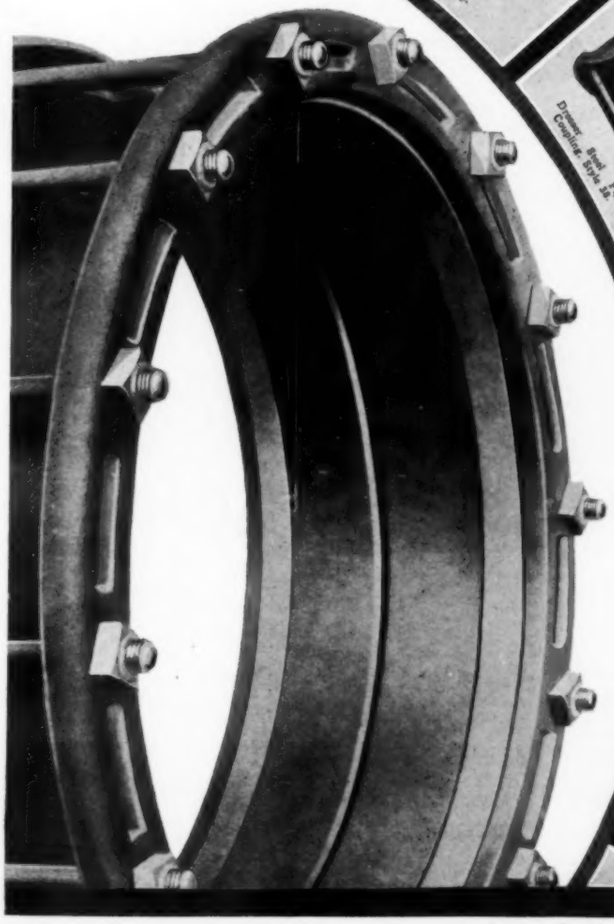


Dresser Steel Pipe Coupling Style 38.

THE first Dresser coupled pipe line, laid more than 40 years ago, has never developed a leak at the couplings. It is still in service. Dresser Couplings, Sleeves, Clamps, and Fittings remain permanently tight. Plumbers and pipefitters who use them once, find them indispensable for new jobs and repairs.

A descriptive folder shows how they save time, labor and material. Ask for it.

S. R. DRESSER MFG. CO.
Bradford :: Pennsylvania

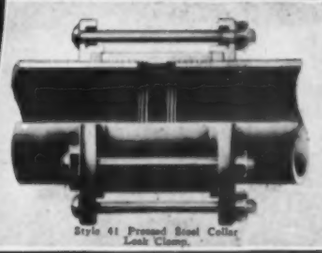


Dresser Steel Long Sleeve Style 40. Same as Style 38 except in length.

Dresser Steel Long Sleeve, sizes 2 in. I. D. to 3 in. O. D.

Dresser Coupling for sizes 2 in. Casing to 3 in. O. D.

Style 38



Style 41 Pressed Steel Collar Leak Clamp.

An Opportunity for

Men with Successful Sales Records

and

Mechanical Designers, Draftsmen

Here is an opportunity for Mechanical Designers and Draftsmen to become affiliated with the Trane Research Laboratories.

Designers must be thoroughly familiar with the layout and design of heating and ventilating equipment. Must be capable of taking ideas and developing them to completion.

The draftsmen we want will be men who have a knowledge of mechanical heating equipment design and operation; who can prepare working drawings and assume responsibility.

The salesmen must be men who have arrived. Great opportunities exist in our sales organization for producers. Past experience will, no doubt, include a successful sales record in the building field with a general knowledge of heating. But men with real records in other fields will be considered.

Let your first letter be complete with your record, your past experience and complete information about yourself. All information will be considered as strictly confidential.

THE TRANE COMPANY

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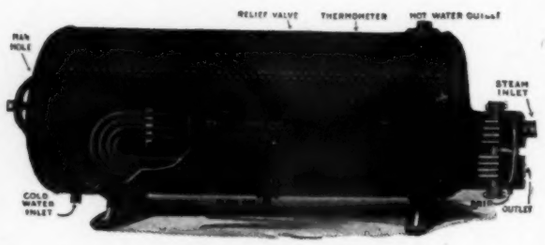
SIMS

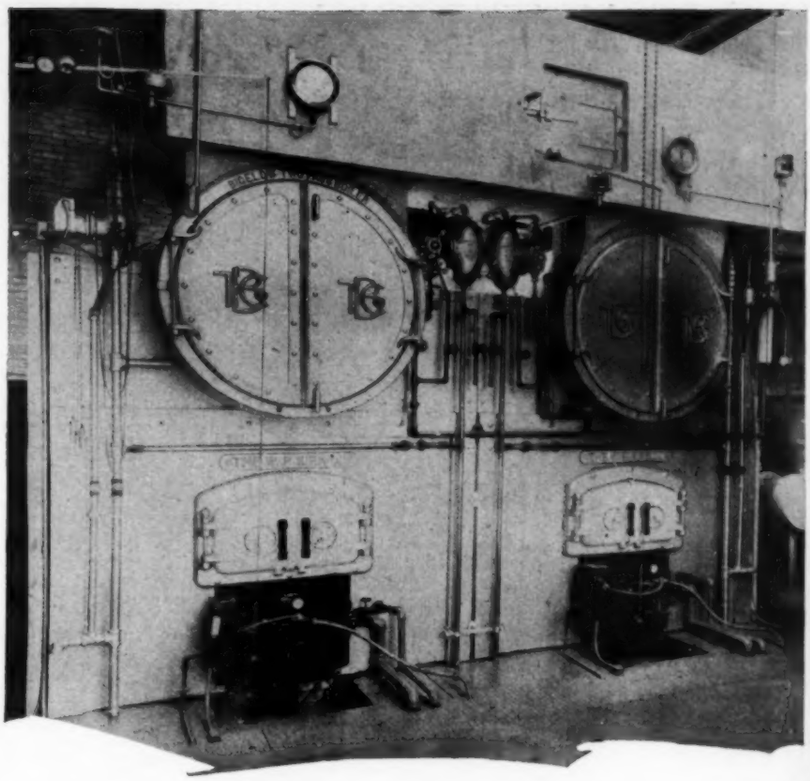
STORAGE TYPE HEATERS AND CONVERTERS

"WE KEEP OTHERS IN HOT WATER"

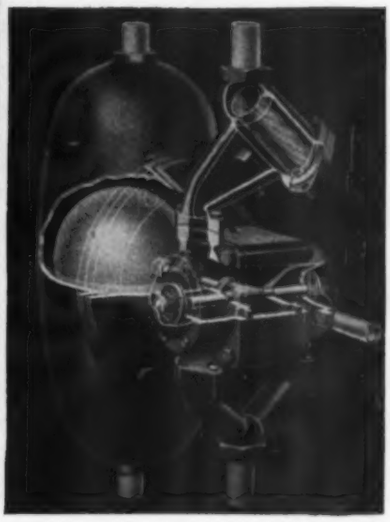


SOME of the largest buildings in the country have been equipped with Sims Storage Heaters and Converters because the Engineer specifying had found by experience that Sims Products were money savers. You too, can guard the jobs for which you are responsible, against breakdown, tie-ups, and poor working efficiency. Specify SIMS wherever hot water is used.

THE SIMS COMPANY P. O. BOX 700 ERIE, PENNA.



This trim installation of McDonnell No. 28 Self-Cleaning Duplex Feeders is in the Southern New England Telephone Co. Bldg., at Bridgeport, Conn. The heating contractor was W. P. Kirk Co. of Bridgeport.



There's nothing wrong with *this* picture!

{The McDonnell Feeders show that the engineer is in step with progress}

For Oil-Fired or Stoker-Fired Jobs

Here is an ingenious combination—the McDonnell No. 30 Safety Feeder combined with the McDonnell No. 31 Emergency Switch. The feeder takes care of normal operation, and the switch takes care of foaming and priming. Entire combination costs little more than the feeder alone.

"To forget is human." That is why people forget the boiler water line. However, there is every indication that an ever-growing number of engineers are *not* forgetting to install the device that *never forgets.*

Each year brings increasing evidence that McDonnell Boiler Feeders are rapidly coming to be regarded as a standard part of the up-to-the-minute heating installation. The engineer who specifies them, proves that he is a long step ahead of the engineer or contractor who doesn't!

There is no longer any reason for limiting McDonnell protection to larger boilers. The McDonnell No. 30 Safety Feeder offers McDonnell dependability and quality in a moderate priced feeder that can be justified for even the smallest boilers. It is ideal for those who prefer a feeder that operates only when the boiler water line drops to the danger level—a modern practice that is advocated by many engineers in connection with moderate or small sized boilers.

Every hand-fired job needs McDonnell protection, and the automatic job fairly shouts for it. The comfort and convenience argument doesn't ring true where it's necessary to watch the boiler water line.

Are you fair to yourself and to those whom you serve, if you refuse to recognize the growing trend toward McDonnell protection for every boiler installation?

McDONNELL & MILLER
1316 Wrigley Building, Chicago
Eastern Office: Grand Central Terminal, New York

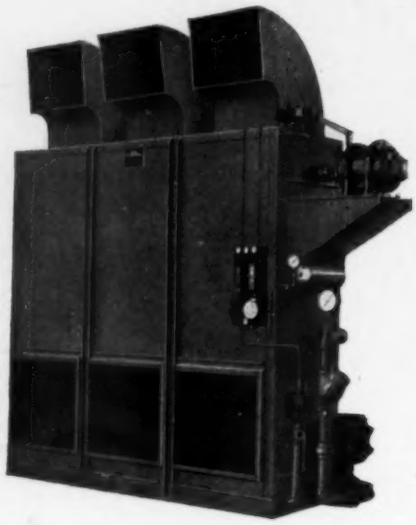
McDONNELL & MILLER
Boiler Feeders

"Doing one thing well"

AIR CONDITIONING

. . . For Large or Small Areas

is most successful by the unit system when Niagara Air Conditioners, individually or in batteries, are installed.



Each Niagara machine is a complete air conditioner. It cleans the air more thoroughly than conventional type washer . . . controls temperature and moisture content within the closest limits by a new and superior control . . . dehumidifies and cools with a maximum of efficiency because saturation is secured.

Niagara Air Conditioners are available in capacities from 800 to 11,000 C. F. M.

Detailed information will gladly be furnished upon request.

NIAGARA BLOWER COMPANY

Air Conditioners
Aluminum Heater Coils
Fan Heaters
Fan Coolers
Cooling Surface
Systems for Cooling, Humidifying Drying, Solvent Recovery Dust Recovery Pneumatic Conveying

General Sales Office: 95 Liberty St., New York City

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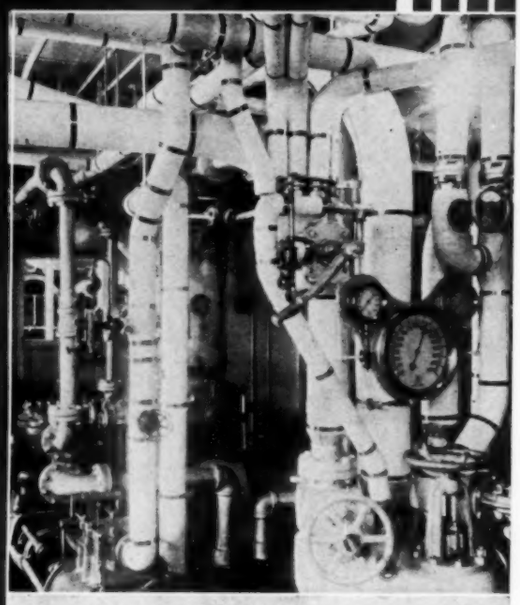
NIAGARA

PIPING by POWER



Men, Methods and Materials . . .

Behind every important fabrication or installation executed by Power Piping Company is a background of men, methods and materials that can result in but one standard of service and satisfaction!

Refineries and power plants appreciate that by letting the contract to this capable organization the specifications will be carried out to assure accuracy in design and economy in operation. Put your piping problems up to

POWER PIPING COMPANY
PITTSBURGH, PA.

FROM A MERE FITTING TO A COMPLETE SYSTEM

Only Hoffman No. 2 Vacuum Valves have All These *Superior Features*

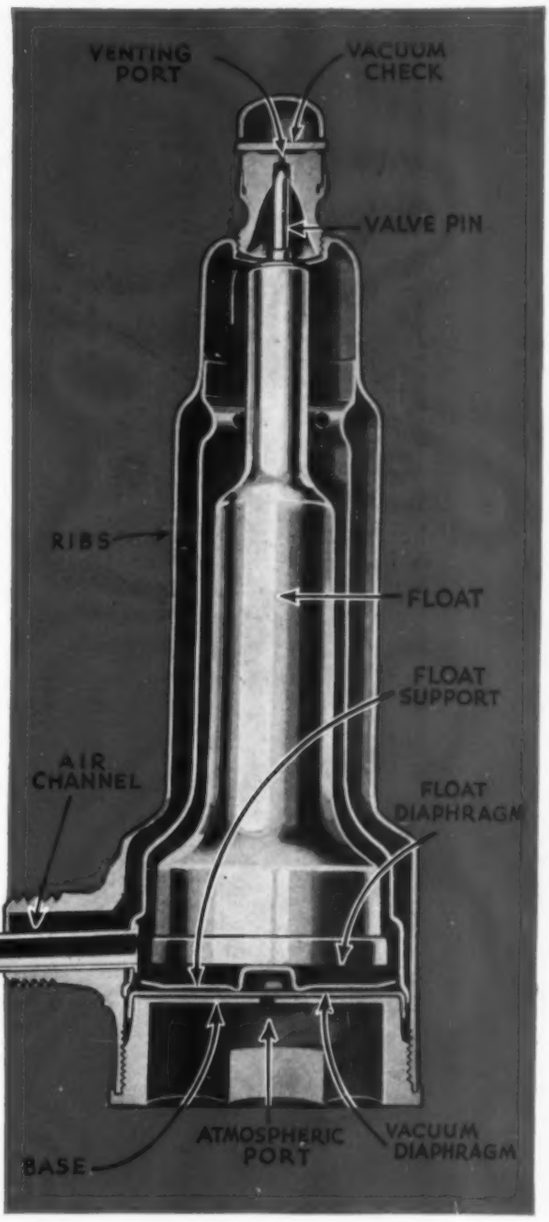
1 Double air locks (vacuum check and vacuum diaphragm).

2 Patented air channels, preventing spitting.

3 Perfect siphon, insuring quick and complete drainage of valve.

4 Snap action of float diaphragm insures wide open or tightly closed vent port.

5 Each valve factory adjusted and sealed, steam and water tested and guaranteed for five years.



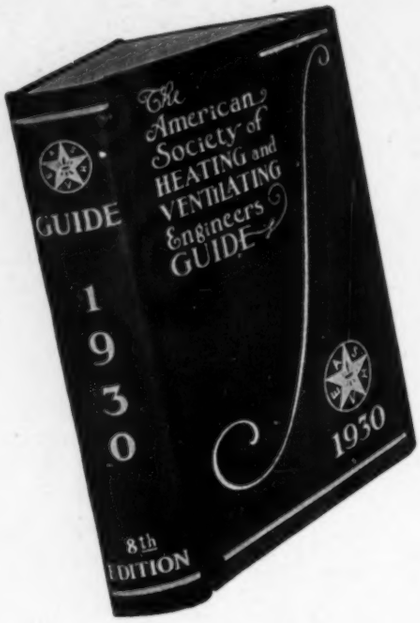
IN all, 279 separate, precise operations are needed to complete one Hoffman Valve. That's why these valves give longer efficient service and require less call-backs after they are installed.

Furthermore, Hoffman valves are *easier to sell*, because millions of property owners are pre-sold for you by Hoffman advertisements appearing in national publications.

Right in your vicinity are hundreds of property owners who are eager to enjoy the comforts and economies of a Hoffmanized heating system.

Get your share of this profitable modernizing work. Let us tell you about the Trial Offer many contractors are using successfully. Write us for particulars. Hoffman Specialty Co., Inc., Dept. FC-20. Waterbury, Conn,

HOFFMAN
No. 2 Vacuum Valves
for one pipe steam systems



The 1930 Edition

"The most important book in the Heating, Ventilating, Piping, and Air Conditioning Industries."

THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS GUIDE for 1930 has added to its already useful pages, important data which makes it even more useful and comprehensive than any of the seven other editions, which have been looked forward to and welcomed as "the most important book in the field."

This unusual book represents the work of not one or two men, but the coordination of the members of the entire Society, and other experts, its Text Pages being prepared by hundreds of America's foremost Engineers, giving their untiring efforts without remuneration, deeming it a great privilege to contribute in this manner to the advancement of their profession. In no other way could so authoritative and useful a book have been produced. The information is not only complete and up-to-the-minute but is accurate and unbiased, based upon the most advanced practice of the day, as developed by research and by the acknowledged leaders in the Industries represented.

The Table of Contents on this page reveals the reasons why THE GUIDE is treasured by Engineers, Architects, Contractors, Estimators and Draftsmen; and is used as a Text Book in many of America's leading Technical Schools.

THE GUIDE is "the most important book in the field" and it should be at your elbow. Convenient 6x9-inch size, fabricoid semiflexible binding, $5.00 per copy.

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8. Air Cleaners.
9. Unit Heaters and Air Conditioners.
10. Heating by Coal.
11. Heating by Gas.
12. Heating by Oil.
13. Heating by Electricity.
14. Chimneys.
15. Boilers
16. Conductors and Convectors for Steam and Hot Water Heating.
17. Automatic Heat Control.
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19. Pumps and Traps.
20. Piping for Steam Heating Systems.
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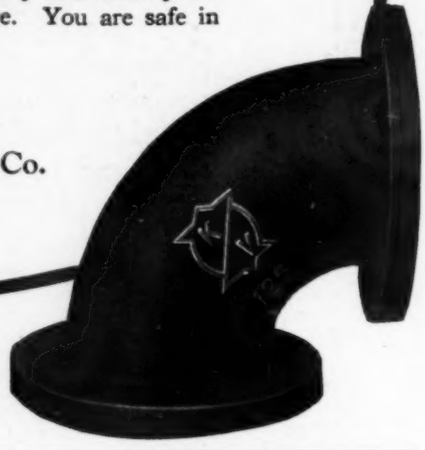

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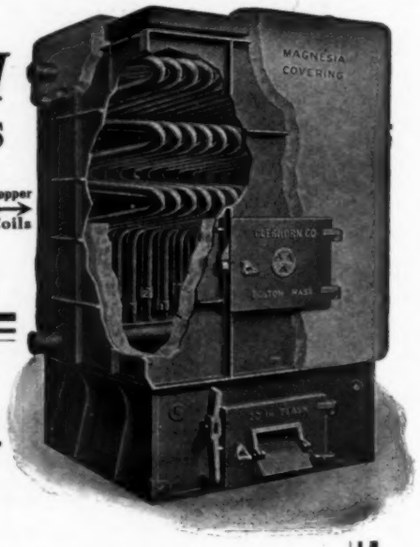

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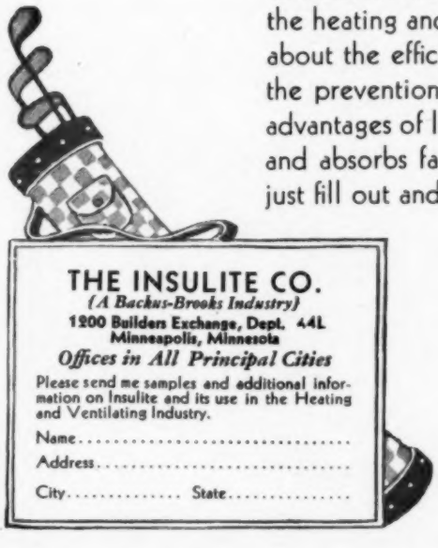

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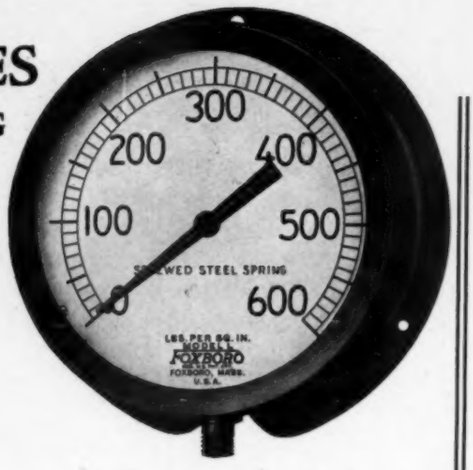

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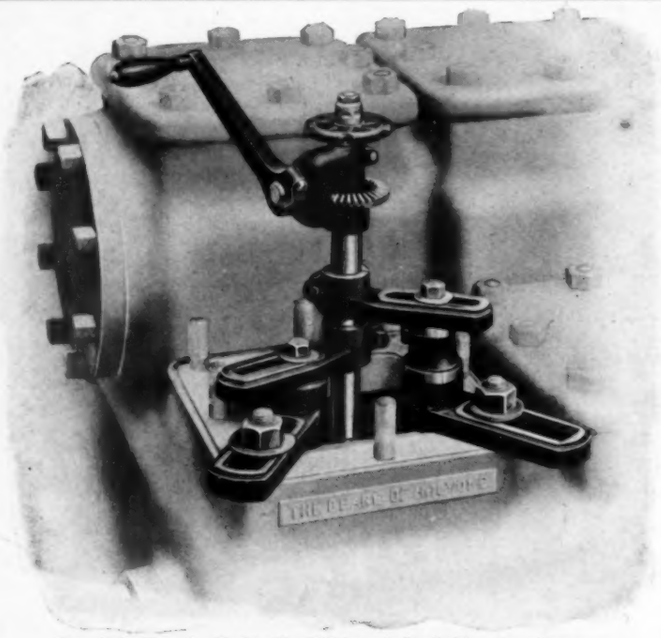

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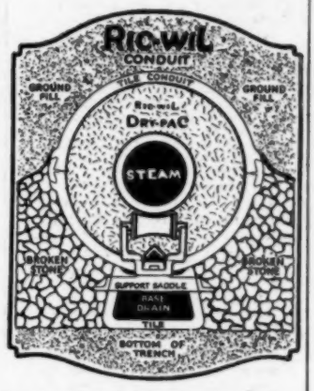

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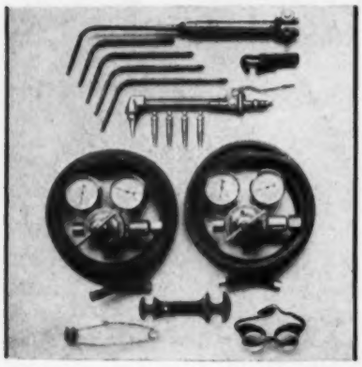

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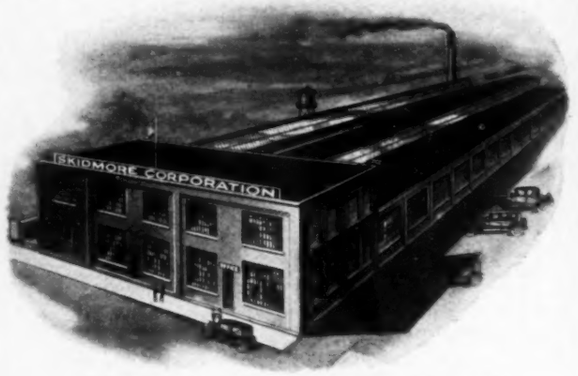

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COVERINGS, PIPE, WOOD
(see Casing, Pipe, Wood)

COVERS AND ENCLOSURES, RADIATOR
American Radiator Co., New York

CUTTERS, PIPE
Crane Co., Chicago.

CUTTING APPARATUS, OXY-GAS
Air Reduction Sales Co., New York
Oxweld Acetylene Co., New York

DAMPENERS, CLOTH
American Moistening Co., Providence, R. I.

DAMPER REGULATORS
(See Regulators, Damper)

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Clarage Fan Co., Kalamazoo, Mich.
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Cooling and Air Conditioning Corp., New York.
Maryland Air Conditioning Corp., Baltimore.
Niagara Blower Co., Buffalo, N. Y.
Sturtevant Co., B. F., Boston
York Heating & Ventilating Co., Philadelphia, Penna.

DRAFT APPLIANCES, MECHANICAL
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Buckeye Blower Co., Columbus, O.
Buffalo Forge Co., Buffalo, N. Y.
National Regulator Co., Chicago
Sturtevant Co., F. B., Boston

DRYING SYSTEMS
(See Systems, Air Drying)

DUCTS, FUME
Duriron Co., The, Dayton, O.

DUST COLLECTING SYSTEMS
(See Systems, Dust Collecting)

DUST COLLECTORS
(See Collectors, Dust)

ECONOMIZERS, FUEL
Sturtevant Co., B. F., Boston

EJECTORS, SEWAGE
Nash Engineering Co., So. Norwalk, Conn.

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American Radiator Co., New York
American District Steam Co., North Tonawanda, New York
Crane Co., Chicago, Ill.

ELIMINATORS, AIR, FOR STEAM AND VACUUM HEATING
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American Radiator Co., New York
Cooling and Air Conditioning Corp., New York.
Dunham Co., C. A., Chicago, Ill.
Hoffman Specialty Co., Waterbury, Conn.
Illinois Engineering Co., Chicago
Marsh & Co., Jas. P., Chicago
Sarco Co., Inc., New York City
Sterling Engineering Co., Milwaukee, Wis.
Trane Co., La Crosse, Wis.
Warren Webster & Co., Camden, New Jersey

EQUALIZERS FOR LOW PRESSURE HEATING
Barnes & Jones, Jamaica Plain, Massachusetts.
Illinois Engineering Co., Chicago.
Warren Webster & Co., Camden, New Jersey.

EQUIPMENT, OIL BURNER IGNITION AND CONTROL
American Radiator Co., New York.

EVAPORATORS, BOILER FEED MAKE-UP
McDonnell & Miller, Chicago, Ill.

EXCHANGERS, HEAT
Watts Regulator Co., Lawrence, Mass.

EXHAUSTERS
Buckeye Blower Co., Columbus, O.
Buffalo Forge Co., Buffalo, N. Y.
Columbus Htg. & Vent. Co., Columbus, O.

EXHAUST HEADS
(See Heads, Exhaust)

EXHAUST SYSTEMS
(See Systems, Exhaust)

EXPANSION JOINTS
(See Joints, Expansion)

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Buckeye Blower Co., Columbus, O.
Buffalo Forge Co., Buffalo, N. Y.
Clarage Fan Co., Kalamazoo, Mich.
Columbus Htg. & Vent. Co., Columbus, O.
Sturtevant Co., B. F., Boston
U. S. Blower & Heater Corp., Minneapolis.

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Buckeye Blower Co., Columbus, O.
Buffalo Forge Co., Buffalo, N. Y.
Clarage Fan Co., Kalamazoo, Mich.
Columbus Htg. & Vent. Co., Columbus, O.
Duriron Co. Inc., The, Dayton, O.
Hartzell Propeller Fan Co., Piqua, Ohio.
Sturtevant Co., B. F., Boston
U. S. Blower & Heater Corp., Minneapolis.
Wing Mfg. Co., L. J., New York
York Heating & Ventilating Corp., Philadelphia, Pa.

FEED WATER HEATERS
(See Heaters, Feed Water)

FEEDERS, BOILER COMPOUND
Sims Co., The, Erie, Pennsylvania.

FEEDERS, WATER, HEATING BOILER
McDonnell & Miller, Chicago, Ill.
National Pipe Bending Co., New Haven, Conn.

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Ric-wil Company, The, Cleveland.

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American Air Filter Co., Inc., Louisville, Ky.
American Blower Corp., Detroit.
Staynew Filter Corp., Rochester, N. Y.

FITTINGS, AMMONIA PIPE
York Ice Machinery Corp., York, Pa.

FITTINGS, BRASS, M. I. PATTERN
Jenkins Mfg. Co., Bloomfield, N. J.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Tube Turns, Inc., Louisville, Ky.

FITTINGS, BRASS, STEAM PATTERN
Jenkins Mfg. Co., Bloomfield, N. J.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Tube Turns, Inc., Louisville, Ky.

FITTINGS, BRINE
York Ice Machinery Corp., York, Pa.

FITTINGS, CARBON DIOXIDE
York Ice Machinery Corp., York, Pa.

FITTINGS, CAST IRON
Limbert & Co., Geo. B., Chicago.

FITTINGS, CAST STEEL
Limbert & Co., Geo. B., Chicago.

FITTINGS, CONDUIT, UNDERGROUND
American District Steam Co., North Tonawanda, New York
Kennedy Valve Mfg. Co., Elmira, N. Y.
Ric-wil Company, Cleveland, Ohio.
Tube Turns, Inc., Louisville, Ky.

FITTINGS, PIPE, BRASS, FOR COPPER SERVICE PIPE
Kennedy Valve Mfg. Co., Elmira, N. Y.

FITTINGS, PIPE, FLANGED
American District Steam Co., North Tonawanda, New York
Crane Co., Chicago, Ill.
Grinnell Co., Inc., Providence, R. I.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Lynchburg Foundry Co., Lynchburg, Va.
Midwest Piping & Supply Co., Inc., St. Louis, Mo.
Power Piping Co., Pittsburgh
Stockham Pipe & Fittings Co., Birmingham, Ala.

FITTINGS, PIPE, HYDRAULIC
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Kennedy Valve Mfg. Co., Elmira, N. Y.
Midwest Piping & Supply Co., Inc., St. Louis, Mo.
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Power Piping Co., Pittsburgh
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Tube Turns, Inc., Louisville, Ky.

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Kennedy Valve Mfg. Co., Elmira, N. Y.
Midwest Piping & Supply Co., Inc., St. Louis, Mo.
Power Piping Co., Pittsburgh
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Taylor Forge & Pipe Works, Chicago.
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Grinnell Co., Inc., Providence, R. I.
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Stockham Pipe & Fittings Co., Birmingham, Ala.
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FITTINGS, VACUUM
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Tube Turns, Inc., Louisville, Ky.

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Crane Co., Chicago, Ill.
Grinnell Co., Inc., Providence, R. I.
Midwest Piping & Supply Co., Inc., St. Louis, Mo.
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Roessing Mfg. Co., Sharpsburg, Pa.
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Lynchburg Foundry Co., Lynchburg, Va.

FLANGES, STEEL PIPE
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Taylor Forge & Pipe Works, Chicago.

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GASKETS, ASBESTOS
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Air Reduction Sales Co., New York
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(See Boards, Gauge)

GAUGE GLASSES
(See Glasses, Gauge)

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Marsh & Co., Jas. P., Chicago, Ill.

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American Radiator Co., New York
Crane Co., Chicago
Hoffman Specialty Co., Waterbury, Connecticut
Marsh & Co., Jas. P., Chicago

GAUGES, EXPANSION TANK
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GAUGES, HYDRAULIC
Marsh & Co., Jas. P., Chicago

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(See Instruments)

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GAUGES, PRESSURE
Air Reduction Sales Co., New York
Crane Co., Chicago, Ill.
Foxboro Co., The, Foxboro, Mass.
Marsh & Co., Jas. P., Chicago, Ill.
Oxweld Acetylene Co., New York

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Dunham Co., C. A., Chicago, Ill.
Foxboro Co., The, Foxboro, Mass.
Illinois Engineering Co., Chicago
Marsh & Co., Jas. P., Chicago, Ill.
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Grinnell Co., Inc., Providence, R. I.
Midwest Piping & Supply Co., Inc., St. Louis
Power Piping Co., Pittsburgh

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Limbert & Co., Geo. B., Chicago.

HEADERS, WELDED, NOZZLE
Crane Co., Chicago
Grinnell Co., Inc., Providence, R. I.
Limbert & Co., Geo. B., Chicago.
Midwest Piping & Supply Co., Inc., St. Louis, Mo.
National Pipe Bending Co., New Haven, Conn.
Philadelphia Pipe Bending Co., Philadelphia
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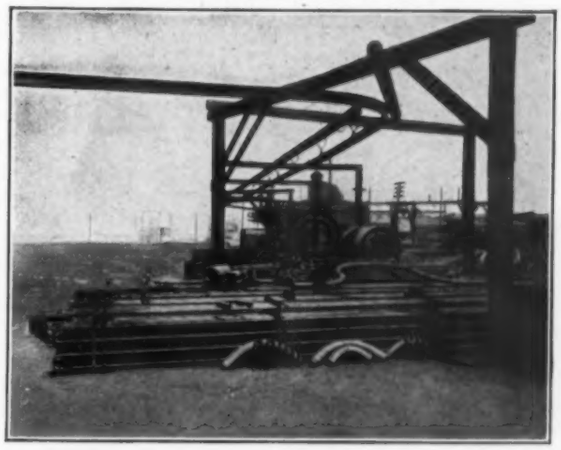

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Buffalo Forge Co., Buffalo, N. Y.
Clarage Fan Co., Kalamazoo, Mich.
Excelso Products Corp., Buffalo.
Modine Mfg. Co., Racine, Wis.
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Wolverine Tube Co., Detroit.
York Heating & Ventilating Corp., Philadelphia, Penna.

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American Blower Corp., Detroit.
Buckeye Blower Co., Columbus, O.
Buffalo Forge Co., Buffalo, N. Y.
Clarage Fan Co., Kalamazoo, Mich.
Columbus Htg. & Vent. Co., Columbus, O.
Dixie Blower Co., Chicago, Ill.
Dunham Co., C. A., Chicago
Grinnell Co., Inc., Providence, R. I.
Modine Mfg. Co., Racine, Wis.
Multicell Radiator Corp., Lockport, N. Y.
Nelson Corp., Herman, Moline, Ill.
Niagara Blower Co., Buffalo, N. Y.
Peerless Unit Ventilation Co., Inc., Bridgeport, Conn.
Perfex Corp., Milwaukee, Wis.
Skinner Bros. Mfg. Co., Inc., St. Louis, Mo.
Sturtevant Co., B. F., Boston
Trane Co., The, La Crosse, Wis.
U. S. Blower & Heater Corp., Minneapolis.
Wing Mfg. Co., L. J., New York
Wolverine Tube Co., Detroit.
York Heating & Ventilating Corp., Philadelphia, Penna.

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Hoffman Specialty Co., Waterbury, Connecticut
Modine Mfg. Co., Racine, Wis.
Sturtevant Co., B. F., Boston
Wing Mfg. Co., L. J., New York
Wolverine Tube Co., Detroit.
York Heating & Ventilating Corp., Philadelphia, Pa.

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Kewanee Boiler Corp., Kewanee, Ill.
National Pipe Bending Co., New Haven, Conn.
Sims Co., The, Erie, Pennsylvania.

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Sims Co., The, Erie, Pennsylvania.

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Excelso Products Corp., Buffalo
Frank Heater & Engineering Co., O. E., Buffalo, N. Y.
National Pipe Bending Co., New Haven, Conn.

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American Radiator Co., New York
Frank Heater & Eng. Co., Inc., O. E., Buffalo, N. Y.
National Pipe Bending Co., New Haven, Conn.
Sims Co., The, Erie, Pennsylvania.

HEATERS, WATER TANK
National Pipe Bending Co., New Haven, Conn.

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(See Systems)

HEATING SYSTEMS, VAPOR
(See Systems)

HEATING SYSTEMS, WATER
(See Systems)

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Crane Co., Chicago.

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(See Convertors, Hot Water)

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Carrier Engineering Corp., Newark, N. J.
Cooling and Air Conditioning Corp., New York.
Doherty-Brehm Co., Chicago.
Grinnell Co., Inc., Providence, R. I.
Maryland Air Conditioning Corp., Baltimore, Md.
National Regulator Co., Chicago
Niagara Blower Co., Buffalo, N. Y.
Powers Regulator Co., Chicago
U. S. Blower & Heater Corp., Minneapolis.
York Heating & Ventilating Co., Philadelphia, Pa.

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(See Regulators, Humidity)

HYGROMETERS
American Moistening Co., Providence, R. I.

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Heggie-Simplex Boiler Co., Joliet, Illinois
Kewanee Boiler Corp., Kewanee, Ill.

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McDonnell & Miller, Chicago

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Grinnell Co., Inc., Providence, R. I.

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INSTRUMENTS, INDICATING AND RECORDING
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Foxboro Co., The, Foxboro, Mass.
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Powers Regulator Co., Chicago, Ill.

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INSULATION, BOILER, PIPE, ETC.
(See Covering, Boiler, Pipe, Etc.)

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Crane Co., Chicago, Ill.
Illinois Engineering Co., Chicago

Taylor Forge & Pipe Works, Chicago.
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LOCKS, VALVE, RADIATOR AIR
Hoffman Specialty Co., Waterbury, Conn.

LOOPS, EQUALIZING OR DIFFERENTIAL
(See Equalizers for Low Pressure Heating)

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Buffalo Forge Co., Buffalo, N. Y.
Clarage Fan Co., Kalamazoo, Mich.
Columbus Htg. & Vent. Co., Columbus, O.
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(See Alarms, Low Water)

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York Ice Machinery Corp., York, Pa.

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Crane Co., Chicago, Ill.
Kewanee Boiler Corp., Kewanee, Ill.
Midwest Piping & Supply Co., Inc., St. Louis
Power Piping Co., Pittsburgh
Reading Iron Co., Reading, Pa.
Roessing Mfg. Co., Sharpsburg, Pa.

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Leavitt Machine Co., Orange, Mass.

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American District Steam Co., North Tonawanda, N. Y.

METERS, FLOW
American District Steam Co., North Tonawanda, New York

METERS, STEAM
American District Steam Co., North Tonawanda, N. Y.

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(See Humidifiers)

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MOTORS, BLOWER
Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.

MOTORS, FAN
Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.

MOTORS, PUMP
Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.

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NOZZLES, SPRAY
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Crane Co., Chicago, Ill.
Grinnell Co., Inc., Providence, R. I.
Marley Co., The, Kansas City, Mo.
York Heating & Ventilating Corp., Philadelphia, Pa.

OIL BURNERS, INDUSTRIAL
(See Burners, Oil)

OIL BURNER IGNITION AND CONTROL EQUIPMENT
(See Equipment)

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Duriron Co., Inc., The, Dayton, O.
Reading Iron Co., Reading, Pa.
Wyckoff & Sons Co., A., Elmira, N. Y.

PIPE BENDING AND COILING
(See Machines)

PIPE, BRASS
Crane Co., Chicago, Ill.
Wolverine Tube Co., Detroit.

PIPE CASING
(See Casing, Pipe, Wood)

PIPE, CAST IRON
American Radiator Co., New York
Crane Co., Chicago, Ill.

PIPE COMBINATION, STEEL AND WOOD
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PIPE COILS
(See Coils, Pipe)

PIPE, FABRICATED
Limbert & Co., Geo. B., Chicago
Lynchburg Foundry Co., Lynchburg, Va.
Midwest Piping & Supply Co., Inc., St. Louis, Mo.
Roessing Mfg. Co., Sharpsburg Station, Pittsburgh.
Wolverine Tube Co., Detroit.

PIPE, FORGE WELDED
Taylor Forge & Pipe Works, Chicago.

PIPE HANGERS
(See Hangers, Pipe)

PIPE, HYDRAULIC
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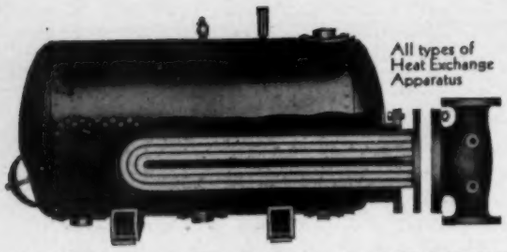

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Columbus Htg. & Vent. Co., Columbus, O.
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Maryland Air Conditioning Corp., Baltimore, Md.
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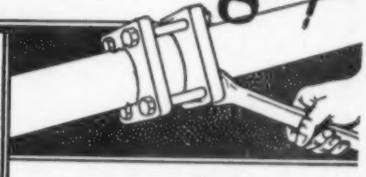

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Illinois Engineering Co., Chicago
Marsh & Co., Jas. P., Chicago
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Sterling Engineering Co., Milwaukee, Wis.
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Columbus Htg. & Vent. Co., Columbus, O.
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TANKS, RECEIVER
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Sims Co., The, Erie, Pennsylvania.
Warren Webster & Co., Camden, N. J.

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(See Systems, Temperature Control)

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(See Instruments, Indicating and Recording)

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(See Regulators, Room Temperature)

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(See Valves, Radiator Return Line)

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Dunham Co., C. A., Chicago, Ill.
Hoffman Specialty Co., Waterbury, Conn.
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Sarco Co., Inc., New York City
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(See Couplings, Tube)

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Wolverine Tube Co., Detroit, Mich.

TUBING, ALUMINUM
Wolverine Tube Co., Detroit, Mich.

TUBING, ALUMINUM, FABRICATED
Wolverine Tube Co., Detroit, Mich.

TUBING, BRASS AND COPPER
Crane Co., Chicago, Ill.
Wolverine Tube Co., Detroit, Mich.

TUBING, BRASS AND COPPER, FABRICATED
Wolverine Tube Co., Detroit, Mich.

TUBING, COPPER, FINNED
Rome-Turney Radiator Co., Rome, N. Y

TURBO BLOWERS
(See Blowers, Turbo)

UNIT HEATERS
(See Heaters, Unit)

UNIT VENTILATORS
(See Ventilators, Unit)

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(see Machines)

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Dunham Co., C. A., Chicago, Ill.
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Strong, Carlisle & Hammond Co., Cleveland.

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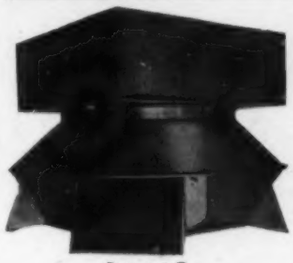

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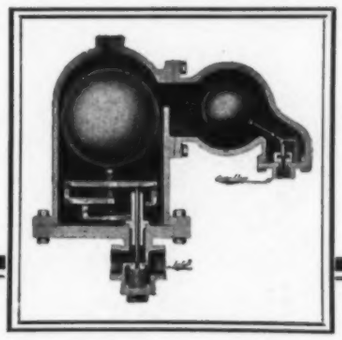

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Hoffman Specialty Co., Waterbury, Conn.
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(Continued on Page 175)

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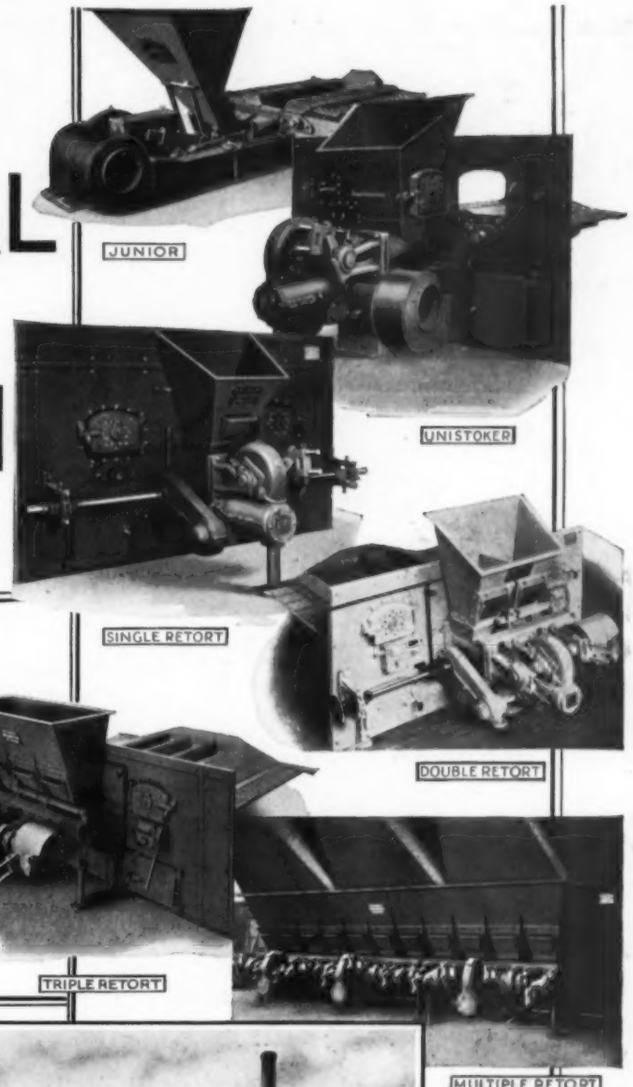

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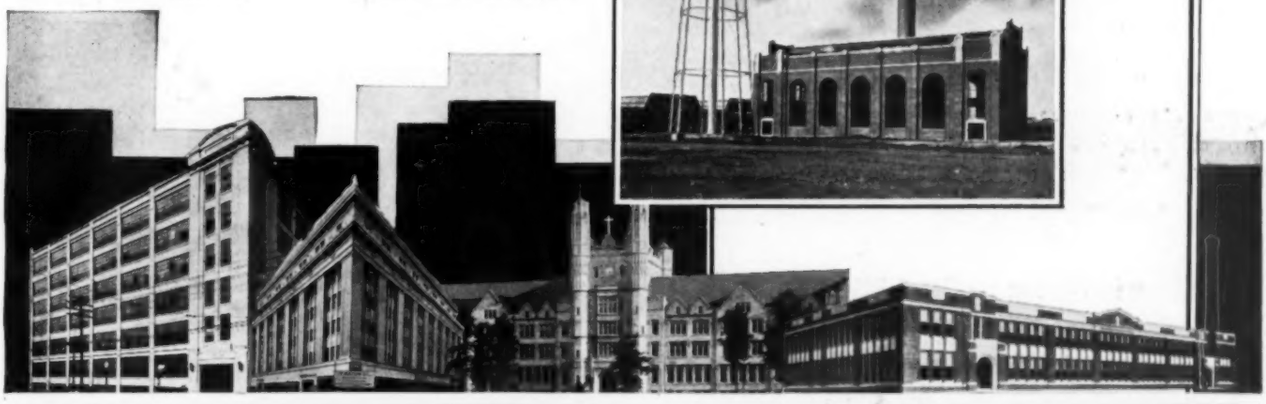

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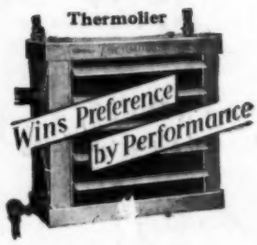

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